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INDIAN AGRICULTURAL  
RESEARCH INSTITUTE, NEW DELHI

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PROCEEDINGS  
of  
THE FLORIDA STATE  
HORTICULTURAL  
SOCIETY for  
**1946**



PUBLISHED BY THE SOCIETY



DR. HERBERT JOHN WEBBER

1865-1946

**PROCEEDINGS**  
OF THE  
**FIFTY-NINTH ANNUAL**  
**MEETING**  
OF THE  
***Florida State Horticultural***  
***Society***  
*And Its Affiliates*

HELD AT  
MIAMI, FLORIDA  
APRIL 30-MAY 1-2  
**1946**



Published by The Society  
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ROBINSONS CHIEF PRESS  
APOPKA, FLORIDA



# Florida State Horticultural Society

## Officers Elect for 1947

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### PRESIDENT

FRANK M. O'BYRNE  
Lake Wales

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EARL W. HARTT  
Avon Park

FRANK STIRLING  
Ft. Lauderdale

W. F. WARD  
Avon Park

DR. DAVID FAIRCHILD  
Honorary  
*Krome Memorial Institute*  
Coconut Grove

DR. G. D. RUEHLE  
*Krome Memorial Institute*  
Homestead

LYLE C. DICKMAN  
*Vegetable Section*  
Ruskin

---

### SECRETARY

DR. RALPH L. MILLER, Plymouth

---

### ASSISTANT SECRETARIES

RALPH H. THOMPSON, Winter Haven

DR. H. S. WOLFE, Gainesville

DR. F. S. JAMISON, Gainesville

---

### TREASURER

FRANK L. HOLLAND, Winter Haven

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### EXECUTIVE COMMITTEE

R. S. EDSALL, Wabasso, *Chairman*

LEM P. WOODS, JR., Tampa

C. D. KIME, Ft. Pierce

FLOYD L. WRAY, Hollywood

DALE TALBERT, Vero Beach



# CONSTITUTION

Article 1. This organization shall be known as the Florida State Horticultural Society, and its object shall be the advancement of Horticulture.

Article 2. Any person or firm may become an annual member of the Society by subscribing to the Constitution and paying three dollars. Any person or firm may become a perennial member of the Society by subscribing to the Constitution and paying the annual dues for five or more years in advance. Any person or firm may become an annual sustaining member of the Society by subscribing to the Constitution and paying ten dollars. Any person may become a life member of the Society by subscribing to the Constitution and paying fifty dollars. Any person or firm may become a patron of the Society by subscribing to the Constitution and paying one hundred dollars.

Article 3. Its officers shall consist of a President, three Vice Presidents, Secretary, Assistant Secretaries, Treasurer and Executive Committee of five, who shall be elected by ballot at each annual meeting. These officers shall take their positions immediately following their election. The duties of the Assistant Secretaries shall be outlined and supervised by the Executive Committee.

Article 4. The regular annual meeting of this Society shall be held on the second Tuesday in April, except when ordered by the Executive Committee.

Article 5. The duties of the President, Vice Presidents, Secretary and Treasurer shall be such as usually devolve on these officers. The President, Secretary and Treasurer shall be ex-officio members of the Executive Committee.

Article 6. The Executive Committee shall have authority to act for the Society between annual meetings.

Article 7. The Constitution may be amended by a vote of two-thirds of the members present.

Article 8. A section of the annual program of the Society shall be devoted to the discussion of sub-tropical fruits, exclusive of the commonly grown varieties of citrus fruits. This section shall be known as the KROME MEMORIAL INSTITUTE. It shall be presided over by a fourth vice president who shall be elected by ballot at each annual meeting by the members in attendance at the Institute. The fourth vice president shall be an ex-officio member of the Executive Committee.

Article 9. The Executive Committee may, at its discretion and on the basis of merit, nominate not to exceed five persons in any one year, for Honorary Membership in the Society. Honorary members shall enjoy all privileges of the Society.

Article 10. A section of the annual program of the Society shall be devoted to the discussion of vegetables and other truck crops. This section shall be known as the VEGETABLE SECTION OF THE FLORIDA STATE HORTICULTURAL SOCIETY. It shall be presided over by a Vice President, who shall be elected at each annual meeting of the Society by the members in attendance at the Section. The Vice President shall be an ex-officio member of the Executive Committee.



## BY - LAWS

1. The Society year shall be co-extensive with the calendar year, and the annual dues of members shall be three dollars.

2. All bills authorized by the Society or its Executive Committee, for its legitimate expenses, shall be paid by the Secretary's draft on the Treasurer, O. K'd by the President.

3. The meetings of the Society shall be devoted only to Horticultural topics, from scientific and practical standpoints, and the presiding officer shall rule out of order all motions, resolutions and discussions tending to commit the Society to partisan politics or mercantile ventures.

4. All patron and life membership dues and all donations, unless otherwise specified by donor, shall be invested by the Treasurer in United States Government bonds. The earnings from these bonds shall be left as accrued values or reinvested in United States Government bonds of a guaranteed periodical value unless it is ordered by the Executive Committee or the Society that such earnings can be made available for operating expense. Receipts from perennial membership dues shall be placed on deposit at interest by the Treasurer. Only three dollars (\$3.00) from each perennial membership fee shall be available during any calendar year for payment of operating expenses of the Society.

# LIST OF MEMBERS

## 1946

### HONORARY MEMBERS

Chase, J. C., Winter Park	Hume, Dr. H. Harold, Gainesville
Fairchild, Dr. David, Coconut Grove	Lipsey, L. W., Blanton
Floyd, W. L., Gainesville	Mayo, Nathan, Tallahassee
Haden, Mrs. Florence P., Coconut Grove	Robinson, T. Ralph, Terra Ceia
Hastings, H. G., Atlanta, Ga.	Swingle, Dr. W. T., Washington, D. C.
Henricksen, H. C., Eustis	Webber, Dr. H. J., Riverside, California
Holland, Spessard L., Bartow	

### PATRON MEMBERS

American Agricultural Chemical Co., Pierce	Hastings, H. G. Co., Atlanta, Ga.
American Fruit Growers, Inc., Maitland	Hillsboro Hotel, Tampa
Angebilt Hotel, Orlando	Klemm, A. M. & Son, Winter Haven
Armour Fertilizer Works, Jacksonville	Lake Garfield Nurseries, Bartow
Buckeye Nurseries	Manatee Fruit Co., Palmetto
Chase & Co., Sanford	Mills The Florist, Jacksonville
Coral Reef Nurseries Co., Homestead	Nocatee Fruit Co., Nocatee
Deerfield Groves, Wabasso	Oklawaha Nurseries Co., Inc., Lake Jem
Deering, Chas.	Peninsular Chemical Co., Orlando
Exchange Supply Co., Tampa	Schnarr, J. & Co., Orlando
Exotic Gardens, Miami	Southern Crate Manufacturers Assn.
Florida Citrus Exchange, Tampa	Stead, Lindsay, P. O. Box 809, Ft. Pierce
Florida East Coast Hotel Co., St. Augustine	Thomas Advertising Service
Florida Grower Publishing Co., Tampa	U. S. Phosphoric Products, Tennessee Corporation, 61 N. Broadway, New York, N. Y.
The Fruitlands Co., Lake Alfred	Van Fleet Co., Winter Haven
Gardner, F. C., Lake Alfred	Wilson & Toomer Fertilizer Co., Jacksonville
Glen St. Mary Nurseries Co., Glen St. Mary	
Gulf Fertilizer Co., Tampa	

All addresses are in Florida unless otherwise shown.

## REGULAR MEMBERS

Life Members shown in capitals

Sustaining Members in italic type

Annual Members in ordinary type

Perennial Members for period shown

- Abbey, O. H., 827 S. E. Second St.,  
Ft. Lauderdale
- Abbott, Charles E., U. of F., Gainesville
- Abbott, Fred P., SAL Ry., Union Station,  
Savannah, Ga.
- Acme Agency, Bme Mitre 552,  
Buenos Aires, Argentina
- Adams, C. W. (Estate), Lake Alfred
- Adkinson, W. Hal, Minneola
- AGRICULTURAL EXPERIMENT  
STATION, Puerto Rico
- ALBERTSON PUBLIC LIBRARY  
Orlando
- ALDERMAN, A. D., Bartow
- Alexander, J. F.*, Bartow
- Alexander, Dr. Taylor, Univ. of Miami,  
Miami
- Alishire, Roy L., 200 Okeechobee Rd.,  
West Palm Beach
- Allen, E. J., Bishop Seed Co., Miami
- ALLENBRAND, ALFRED, 2911 6th  
Ave. North, St. Petersburg 6
- Allison, Eaves, Box 310, Tampa.
- Allison, Dr. R. V., Everglades Exp. Sta.,  
Belle Glade
- Allsopp, Harold L., 515 S. Aiken Ave.,  
Pittsburgh, Pa.
- Alsmeyer, Louis H., Sebring
- American Potash and Chemical Corp.  
214 Walton Bldg., Atlanta, Ga.
- American Potash Institute, Inc.  
710 Mortgage Guarantee Bldg.,  
Atlanta, Ga.
- Andersen, Dr. E. M., Rhode Island  
State College, Kingston, R. I.
- Anderson, Lawrence B., Mulberry
- ANDREWS, C. W., John Crerar Library,  
Chicago, Ill.
- Andrews, W. R. E., Brookline Chemical  
Works, Baltimore, Md.
- Ansel, Edwin J., La Orduna, Ver., Mexico
- Arzave, Ing. Genaro, Apartado 102,  
Monterrey, N. L., Mexico
- Atkins, C. D., Winter Haven
- Atkinson, E. L., Umatilla
- Atwood, Dona, 663 Lincoln Rd.,  
Miami Beach
- Ausley, Paul C.*, 716 Mtg. Guarantee Bldg.,  
Atlanta, Ga.
- Backus, F. E., Box 283, Frostproof
- Bailey, E. R., Sanibel Packing Co., Sanibel
- Bair, Dr. Roy A., Everglades Exp. Sta.,  
Belle Glade
- Barber, B. D., Box 685, Clearwater
- BARBER, C. F., Macclenny
- Barber, Louis E., Winter Haven
- Barker, J. P., Box 1230, Tallahassee
- Barksdale, D. N., Box 2567, Mulberry
- BARTLUM, W. LEONARD, Florida  
Agricultural Supply Co., Orlando
- Baskin, J. L., Box 1050, Orlando
- Bass, C. A., 79 NW 34th St., Miami
- Baumgartner, T. R., 725 NE 113th St.,  
Miami
- Beardsley Farms*, Clewiston
- Beckenbach, Dr. J. R. Vegetable Crops  
Laboratory, Bradenton
- Beerhalter, A.*, Ft. Pierce
- Bellows, J. M., Hector Supply Co., Miami
- Benitez, Lic. Jose, Edificio La Nacional,  
Monterrey, N. L., Mexico
- Bennett, Chas. A., 1825 NW 21st St., Miami
- Bennett, H. W., Box 350, Gainesville
- BERGER, MRS. E. W., Gainesville
- Bergstrom Trading Co.*, 233 Broadway,  
New York, 7, N. Y.
- Bigelow, Clarence E. Rogers,  
835 Cherry St., SE,  
Grand Rapids, Mich.
- Bingham, H. R., Bingham Seed Co.,  
Jacksonville

- Biscayne Park Estate, Box 297, N. Miami  
 Bischoff, Wm. H., Miami Daily News, Miami  
 Bishop, Robt. J., Box 3791, Orlando  
 Blackmon, G. H., Agr. Exp. Sta.,  
     Gainesville  
*Blandford Groves*, Lake Jew  
 Boltin, H. H., Dade City  
 Booth, J. B. Jr., Tavares  
 Borders, H. I., Dept of Plant Pathology,  
     U. of Minnesota, St. Paul, Minn.  
*Boswell, Ralph*, c/o Citrus Magazine,  
     110 Oak St., Tampa  
 Botzenhardt, E. W., 4340 Audubon Ave.,  
     Detroit, Mich.  
 BOUIS, CLARENCE G., Box 6, Ft. Meade  
 Bourland, V. E., Winter Garden  
 Bourne, Dr. B. A., Clewiston  
 Boyd, F. E., Box 120, Montgomery, Ala  
 Bradbury, Chas. O., Beymer Bldg.,  
     Winter Haven  
 Brady, R. C., Titusville  
 Briggs, W. R., Ft. Pierce  
 Bright, L. H., Clewiston  
 BRINGHAM, M. S., Micco  
 BRITT, JOHN F., Ft. Pierce  
 Brock, G. R., Box 506, Cocoa  
 Brockway, E. K., Clermont  
 Brooks, Dr. Chas., 110 N. Shine St.,  
     Orlando  
 Brooks, J. R., Box 36, Homestead  
 BROWN, A. C., Gainesville  
 Brown, R. L., Box 132, Ft. Pierce  
 Brown, R. S., Box 821, Ft. Lauderdale  
 Brown, T. O., Brown & Co., Frostproof  
*Bryan, R. L.*, Bartow  
 Bubel, Joseph, 215 Mendoza, Coral Gables  
 Buckels, W. V., Box 86, Leesburg  
 Burg, Roy N., Loxahatchee  
 Burrichter, August, Homestead  
 Buskirk, R. J., 560 W. Peachtree St.,  
     Atlanta, Ga.  
 Butts, Donald, Florida Citrus Commission,  
     Lakeland  
 Cadmus, Harold J., Box 254, Apopka  
 Calkins, Mrs. O. W., Rt. 1, Box 64,  
     Homestead  
*Campbell, Courtney*, Food Machinery  
     Corp., Dunedin  
*Carlton, R. T.*, Plymouth  
 Carlton, R. A., Box 1986,  
     West Palm Beach  
 CARNEGIE, MRS. T. M., Fernandina  
 Case, A. H., U. S. Phosphoric Prod.,  
     61 Broadway, N. Y.  
 Cass, N. D., Haines City  
 CHAMPLAIN, A. E., RFD No. 1, Palmetto  
 Chang, Chen-Kwan, Box 69, Berwyn, Md.  
 Chaplin, Charles, Rt. 1, Ft. Lauderdale  
 Charles, Wilbur G., Box 323, Winter Haven  
 Chase, Frank K., Cherokee Trail, Lakeland  
 CHASE, JOSIUA C., Winter Park  
 Chase, S. O., Jr., Box 599, Sanford  
 Chicone, Jerry J., Box 9, Winter Haven  
 CHIDESTER, D. D., 446 Painter Ave.,  
     Whittier, Calif.  
 Choate, E. S., Eustis  
 Chryst, T. L., Bradenton  
 Citrus Grove Development Co.  
     Babson Park  
 City of Lakeland, Lakeland  
 Clayton, H. G., Gainesville  
 CLEMENT, WALDO P., Georgiana  
 Coe, Dana G., 1425 Providence Road,  
     Lakeland  
 Coffee, Fred F., Armour Fert. Works,  
     Jacksonville  
 Coit, Dr. J. Elliot, Box 698,  
     Fall Brook, Calif.  
*Colee, Harold*, 510-16 Hildebrandt Bldg.,  
     Jacksonville  
 Collins, Paul F., Haines City  
 Conley, Howard A., 7134 Abbott Ave.,  
     Miami Beach  
 CONNER, WAYNE E., New Smyrna  
 Connor, F. M., SAL Rwy., Palmetto  
 COOK, R. F., Leesburg  
 Coolidge, J. W., Rt. 1, Ft. Pierce  
 Cooper, Hal B., Box 307, Safety Harbor  
 Cooper, Dr. Wm. C., USDA Texas Sub-  
     Station 5, Weslaco, Texas  
 Coral Reef Nurseries Co., Box 596,  
     Homestead  
 Cotton, Dr. R. H., Plymouth  
 Cox, J. C., Wheeler Fert. Co., Oviedo

Cox, Norman H., City of Miami, Miami  
Crenshaw-McMichael Seed Co.

Box 1314, Tampa

Crumb, Frank K., Box 307, Lakeland

CRUTCHFIELD AND WOOLFOJK

Pa. Produce Building, Pittsburgh, Pa.

Curl, Laurence A., Box 288, Winter Haven

Curry, Kenneth, 1600 Melrose Place,

Knoxville, Tenn.

Dale, N. E., Box 15, Winter Garden

Dalrymple, C. D., Oneco

Davidson, W. M., 243 Maple Ave.,

Takoma Park, Md.

Davidson, Z. C., Leesburg

Davis, C. Kay, Ft. Lauderdale

Davis, Charles P., Box 947, Winter Haven

Decker, Dr. Phares, Fla. Agr. Exp. Sta.,

Gainesville

Dennison, Dr. R. A., Fla. Agr. Exp. Sta.

Gainesville

Dickey, R. D., Agr. Experiment Station,

Gainesville

Dierberger, Snr. Joao. Institute Mackenzie,

Rua Maria Antonia 403,

Sao Paulo, Brazil

Di Giorgio Fruit Corp. (1941-46)

Box 780, Winter Haven

Di Giorgio, J. S., Box 780, Winter Haven

Dixie Lime Products Co., Ocala

Dolan, F. M., 1817 Granada Blvd.

Coral Gables

Dixie Lime Products Co., Ocala

Donaldson, C. S., Avon Park

Dorn, H. W., South Miami

Dowdell, R. S., 61 W. Central, Orlando

Doyle, Capt. Walter S., Gen. Del.

Vista, Calif.

Dozier, G. L., Naco Fert. Co., McIntosh

DuCharme, E. P., Lake Alfred

DuManior, George, 1820 W. 25th St.,

Sunset Isle, Miami

DUNEDIN PUBLIC LIBRARY, Dunedin

Dunn, Hershel, Ft. Pierce

Dunne, John M., 3650 N. W. 20th Ave.,

Miami

Dye, John B. Jr., Ft. Lauderdale

Dye, John B. Sr., Ft. Lauderdale

Edsall, Henry J., Bradenton

Edsall, R. S., Wabasso

Eggleston, Harold J., 433 E. Gore Ave.,

Orlando

Ellis, Russell B., Box 44, Little River

Station, Miami

Ellsworth, Miss Wilma J., Rt. 1, Dade City

Engle, Robt. H., 616 Investment Bldg.,

Washington, D. C.

Estes, H. O., Haines City

FAIRCHILD, DR. DAVID

4013 Douglas Road, Coconut Grove

FAIRCHILD, MRS. DAVID

4013 Douglas Road, Coconut Grove

Faircloth, E. V. (Jack), S. Dixie,

West Palm Beach

Far South Growers, Goulbs

Fascell, Michael, 1661 Coral Way, Miami

Fawcett, Chas. F., Box 186, Orlando

FENTON, ALFRED, 1002 Second Nat.

Bank Bldg., Houston, Texas

Ferry, S. K., Box 668, Miami

Fifield, W. M., Agr. Exp. Sta., Gainesville

Fitzsimmons, L. H., Rt. 1, Ft. Lauderdale

Florida Agricultural Research Institute

Winter Haven

Florida Dolomite Co., Pembroke

Floridagold Citrus Corps., Lake Alfred

(Melbourne)

Fogg, Harry W., Box 774, Eustis

Forsee, W. T., Everglades Exp. Sta.,

Belle Glade

Fort Lauderdale Public Library

Ft. Lauderdale

Fosgate Co., Chester C.

Box 2673, Orlando

Fried, Julius, 1003 Subway Term. Bldg.,

Los Angeles, Calif.

Friend, W. H., Valley Exp. Sta.,

Weslaco, Texas

Fruitlands Company, The, Lake Alfred

Fudge, Dr. B. R., Lake Alfred

Fuller, Wm. Allison, 6 Sunrise St., Cocoa

Futch, Ivey E., Lake Placid

Gardner, F. C., Lake Alfred

Gardner, Mrs. F. C., Lake Alfred

- Gardner, Dr., F. E., 415 N. Parramore St.,  
Orlando
- Garrett, Chas. A., Rt. 1, Kissimmee
- Gervec, Ray*, Food Machinery Corp.,  
Dunedin
- GIFFORD, DR. JOHN, Coconut Grove
- Goodwin, E. H., 1480 Monroe St.,  
Riverside, Calif.
- Goodwin, J. C., 504 Seagle Bldg., Gainesville
- Gould, Chester N., Star Route, Box 23,  
West Palm Beach
- Grant, A. J.*, 259 Scotland St., Dunedin
- Gratz, Dr. L. O., Agr. Exp. Sta., Gainesville
- Graves, Forrest C., Vero Beach
- Graw, La Monte, Fla. Veg. Comm.,  
Orlando
- Green, L. C., Highlands Fert. Co., Sebring
- Griencisen, L. Jr.*, Weirsdale
- Griffin, Ben Hill, Jr.*, Box 155, Frostproof
- Griffiths, J. T., Lake Alfred
- Griswold, H. B., 459 West Road,  
La Habra, Calif.
- Groebe, R. H., Barrett Div., Cocoa
- Groff, Dr. G. W., Laurel
- Grossenbacher, J. G., Plymouth
- Grove, W. R., Laurel
- Growers Fertilizer Cooperative*,  
Lake Alfred
- GUEST, MRS. AMY, 465 East 57th St.,  
New York
- Gulf Fertilizer Co.*, Box 2721, Tampa
- Gunn, C. D., Rt. 3, Box 40A, Gainesville
- HADEN, MRS. FLORENCE P.  
Coconut Grove
- Haines City Heights, Inc., Haines City
- HAKES, L. A., P. O. Box 771, Orlando
- Hall, Willis W., 700 S. W. 2nd Ave.,  
Miami
- Hamilton, Joseph, Route 1, Box 449,  
Yuma, Arizona
- Hammerstein, C. P., Flamingo Groves, Inc.,  
Hollywood
- Hanna, L. C., Hanna Road, Lutz
- Harding, Dr. Paul L., 415 N. Parramore  
St., Orlando
- Hardwick, J. D., Box 69, West Palm Beach
- Harkness, R. R., 6321 N. W. 29th Terr.,  
Miami
- Harrison, A. L., Box 510, Bradenton
- Hartt, S. Y., Box 356, Avon Park
- Hartt, S. Y. Jr., Box 356, Avon Park
- HASTINGS, H. G.*, 16 West Mitchell St.,  
Atlanta, Ga.
- Hastings, W. Ray, Box 675,  
Harrisburg, Pa.
- Hastings, Mrs. W. Ray, Box 675,  
Harrisburg, Pa.
- Havelow, Mrs. DeWitt, 1439 Inspiration  
Dr., La Jolla, Calif.
- Hawkins, H. E. C.*, St. Augustine
- Hayman, W. Paul, Box 711, Bartow
- Haynes, Bayless W.*, Wilson and Toomer  
Fert. Co., Box 4459, Jacksonville
- Heid, Dr. J. L., Box 83, Winter Haven
- Heinlein, Mrs. Herman, Rt. 2, Box 92,  
Homestead
- Henderson, H. C., 141 E. Central,  
Winter Haven
- HENRICKSON, H. C., Box 1045, Eustis
- Henry, Arthur M., 1177 Zimmer Dr., N. E.,  
Atlanta, Ga.
- Henry, W. M., SAL Ry., Plant City
- HERNANDEZ, PEDRO, 108 Cienfuegos,  
San Fernando, Cuba
- Highfill, L. R., Cocoa
- Hildebrand, E. M., Food Machinery  
Corp., Dunedin
- Hines, T. R., Box 2721, Tampa
- Hodges, Dan, Box 1273, Tampa
- Hodnett, A. P., Box 958, Winter Haven
- Hodnett, J. Victor, Box 958, Winter Haven
- Hoenshel, Paul M., Box 331, Stuart
- Hogan, Ivey, Ft. Lauderdale
- Holden, B. H., Rt. 2, Box 486, Homestead
- Holland, Frank L.*, Box 392, Winter Haven
- Holtsberg, Bertha* (1942-46), 99 Courtland  
Ave., New Rochelle, N. Y.
- Holzcker, Richard, Lake Wales
- Hookom, D. W., Box 1077, Pinecastle
- Hopkins, Dr. F. F., Citrus Experiment  
Station, Lake Alfred
- Houghtaling, F. S., Rt. 2, Box 1054,  
Miami 38
- Houghtaling, Nestor, Rt. 2, Box 1054,  
Miami 38
- Hsi, Yu-Tseng, Box 69, Berwyn, Md.

- Hughes, David, 116 S. Miami Ave.,  
Miami 38
- Hughes Ranch, Elcouch, Texas
- Hughes Thomas, Rt. 2, Ft. Pierce
- Hughson, Wm. R., Rohm & Haas Co.,  
Philadelphia, Pa.
- HUME, H. HAROLD, Gainesville
- Hunt, D. A.*, Hunt Bros., Lake Wales
- Hunter, Wm. P., 1039 Cypress St.,  
Gainesville
- Huppel, J. B., 2010 Delaney St., Orlando
- Husman, Dr. Verner, Virginia Polytechnic  
Inst., Blacksburg, Va.
- Hwang, Ko Hysin, c/o Dr. Boyce, Citrus  
Experiment Station, Riverside, Calif.
- Ingle, J. L., Stauffer Chem. Co., Apopka
- IOWA STATE COLLEGE LIBRARY,  
Ames Iowa
- Jacobs, W. A., Box 416, Delray Beach
- JACOCKS, A. J., Winter Haven
- Jamison, Dr. F. S., Agr. Exp. Sta.,  
Gainesville
- Jamison, Dr. V. C., Citrus Exp. Sta.,  
Lake Alfred
- Janes, Byron E., Agri. Exp. Sta., Gainesville
- Johnson, Warren O., Box 1058, Lakeland
- Jones, H. S.*, Box 1021, Vero Beach
- Jones, R. S.*, Wilson and Toomer Fert.  
Co., Box 4459, Jacksonville
- Jones, W. J., Di Giorgio Fruit Corp.,  
Winter Haven
- Jordahn, A. C., Box 292, Miami 33
- Kanawha Groves Co.*, Ft. Pierce
- Kaspar, P. E., Sherwin Williams Co.,  
Tampa
- Keenan Soils Laboratory (1942-46)  
Frostproof
- Kelsheimer, E. G., Veg. Crops Lab.,  
Bradenton
- Kendall, Harold E., Goulds
- Kensett, J. G., 2612 Jetton Ave., Tampa
- Kent, L. D., 3850 Poinciana Ave.,  
Miami 33
- Kent, Miss Olga, 3850 Poinciana Ave.,  
Miami 33
- Kew, Theodore J., 1721 Westchester Ave.,  
Winter Park
- Kew, Mrs. Theodore J., 1721 Westchester  
Ave., Winter Park
- Kilgore Seed Co. The*, Plant City
- Kime, Chas. D. Jr., Box 102,  
Florence Villa
- Kime, Chas. D., Box 232, Ft. Pierce
- Kinard, R. R., Box 607, Homestead
- King, Batty, Bonita Springs
- Kingham, Fern, Box 53, Davenport
- Kitchen, E. M., Pacific Coast Borax Co.,  
51 Madison Ave., New York 10, N. Y.
- Kramer, L. H.*, Lake Wales
- Krome, William H., Box 596, Homestead
- Krome, Mrs. W. J., Box 596, Homestead
- Lake Garfield Nurseries*, Bartow
- LaMont, Henry, Rt. 2, Ft. Pierce
- LASSEN, H. C., Garden Spring Terrace,  
Saratoga, Calif.
- LAUMAN, G. N., Ithaca, New York
- Lawless, Wm. W., Citrus Exp. Sta.,  
Lake Alfred
- Lawrence, R. H., Box 353,  
Camarillo, Calif.
- Layman, C. C., 6605 N. W. 3rd Ave.,  
Miami 38
- Lee, C. S., Oviedo
- LEONARD, GEORGE V., Hastings
- Lesley, John T., Haines City
- Lewis, D. E., Box 315, Carrizo Springs,  
Texas
- Lewis, H. F., Terra Ceia  
Library, Citrus Exp. Sta., Riverside, Calif.
- Library, Cleveland Public, 325 Superior  
Ave., N. E., Cleveland, Ohio
- Library, Univ. of California, 405 Hilgard  
Ave., Los Angeles 24, Calif.
- Library, College of Agri., Univ. of  
Calif., Davis, Calif.
- Library, Univ. of Arizona, Tuscon, Ariz.
- Library, Fla. Agri. Exp. Sta., Gainesville
- Library, City of Lakeland, Lakeland
- Library, U.S.D.A., Washington, D. C.
- Library, Col. of Agri., Mayaguez,  
Puerto Rico
- Library, Univ. of Calif., Berkeley, Calif.

- Library, Duke Univ., Durham, N. C.  
 Library, State Board of Education,  
   Corvallis, Oregon  
 Library, Univ. of Ill., Urbana, Ill.  
 Library Board, State, Tallahassee  
 Lingle, H. G., Box 22, Sanford  
 Link, Cora Eileen, RFD 1, Ft. Lauderdale  
 Lipscomb, S. F., Bartow  
 Little, C. S., Odessa  
 Livingston, Bert, Florida Grower, Tampa  
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# PROCEEDINGS OF THE FLORIDA STATE HORTICULTURAL SOCIETY, 1946

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# EDITORIALS

## TIME SCHEDULES

A trial for all sections of the Society this year of the policy of assigning a definite hour for each paper to be given proved the value of thus scheduling the addressing. For its complete success, however, the plan requires courageous chairmen who will start and stop papers on time. The advantages of knowing what paper is being read at a given time in any section are obvious for those who have interest in more than one section. In addition there is assurance that papers scheduled for the morning will not be postponed until afternoon, or that a paper one came to hear in the afternoon was read in the morning because of getting through unexpectedly early.

## INFORMAL SPEAKERS

The invocation for the opening session was made by the Rev. Glenn C. James, pastor of the White Temple Methodist Church in Miami. In the absence from the city of Mayor Perrine Palmer, the customary address of welcome was given by Mr. Dan Rosenfelder, Director of Public Safety and Acting City Manager. He demonstrated the practical quality of his ideas on hospitality by offering members of the Society absolution from the consequences of parking overtime during the meeting period, instead of the traditional key to the city. The response was made by the Society's experienced responder and 1st Vice-president, Mr. Frank Stirling.

The annual address made to the Society by its President may be read in these Proceedings, and it was followed by a tribute to the late Secretary Floyd, read by his successor, Secretary Miller. In adding his own brief personal testimony regarding Colonel Floyd, President O'Bryne quietly remarked that he had suffered a deep loss also. Mrs. O'Bryne had passed away only two weeks before the meeting, but she had especially asked that he

The Fifty-ninth Annual Meeting of the Florida State Horticultural Society was held in Miami on April 30 and May 1 and 2, 1946. The keynote of this meeting was enjoyment of the opportunity to relax from the arduous work of the war years; yet the "good time" came second to a sound program of reports on horticultural problems. It had been the plan of our late Secretary, B. F. Floyd, that this should be an occasion of good fellowship and his plans were carried out in this respect.

The Columbus Hotel served as headquarters of the Society, with the adjoining McAllister Hotel helping to carry the load. The general sessions and those of both the Citrus Section and the Krome Memorial Institute were comfortably accommodated in the Biscayne Park Assembly Hall, while the Vegetable Section found satisfactory meeting space in the McAllister Hotel. Fortunately the weather was fine during the whole period of meeting, and the six blocks walk from hotel to park building was a pleasant exercise.

The City of Miami made every effort to assure the success of the meetings. Parking space was provided without necessity of using the parking meters with which the city is afflicted. A piano was provided for the opening session and also an attractive and accomplished pianist, Miss Brownie Haston, together with a well-known song-leader, Mr. Adolph Seerth, who gave the Society a quarter hour of uninhibited singing. Police escort was provided for the motorcade to the Fairchild Garden also. All of this was the result of the cordial cooperation of the Miami Convention Bureau, whose staff met with representatives of the Society early in the spring to plan this meeting and followed up those plans right through the meeting period. Only in its peculiar time, which upset calculations of arrival hour from all other parts of the state, did Miami fail in hospitality.

carry on his official duties and do his best to make the meetings he had planned successful ones, and so he had come.

An informal address not scheduled on the program was made by Senhor Julio S. Gonzales, who introduced himself as Director of the Refrigeration Research Station of the Brazilian Department of Agriculture. He gave assurance of his personal assistance to any investigators who might go to Brazil to study the "tristeza" disease.

#### ADDRESS BY WOODRUM

In following its customary practice of inviting some man prominent in national agriculture to address it, the Society had the pleasure this year of hearing the Hon. Clifton A. Woodrum, for many years a congressman from Virginia and now President of the American Plant Food Council, Washington, D. C. He spoke without manuscript, calling attention to the relatively large per capita acreage of arable land in this country and to the importance of maintaining its productivity. The American Plant Food Council is composed of fertilizer manufacturers, whose interest is best served by the enlightened fertilizer practices which maintain or improve soil fertility for crop producers.

#### ENTERTAINMENT FEATURES

Wednesday afternoon and evening were set aside in the program for recreation and entertainment. An invitation from Dr. David Fairchild to visit the Fairchild Tropical Garden south of Coconut Grove was accepted by a large number of members of the Society and their wives, and about 50 automobiles formed a motorcade leaving the hotel headquarters a little after 2 o'clock. At the Garden the option was given of wandering about alone or of following Dr. Fairchild among the trees of the palm collection and hearing him discourse on them. Punch and cookies were served at the museum of the Garden from 4 to about 6 o'clock by the courtesy of the Garden trustees. This was a very interesting and informative afternoon for all who took advantage of

it. Others found recreation in fishing, golf and other sports.

Wednesday night the Society was its own host at a dinner at one of the large restaurants in Miami, Lilley's. The special features were a floor show and the lack of any after-dinner speeches, so that nothing serious marred the enjoyment of the evening.

Following the conclusion of the meetings, a number of Society members took advantage of the nearness of Miami to Cuba and spent a day or two on our island neighbor. This was not the first time that the Society has planned and executed such a post-convention trip to Cuba, but it is the first time that air transportation has been the only means of making the journey. So little time is spent in crossing the water by air that one could go and return within 24 hours, yet have seen a great deal of interest. There was no single routine followed by all, as each one could plan his own itinerary and take his own time for going and coming, within very flexible limits.

#### 1947 MEETING

Several important items of business were transacted by the Society, in addition to the routine adoption of committee reports. Throughout most of its history the Society has met annually in the spring during April or May. For some time there have been heard suggestions that a fall meeting might be easier for both citrus and vegetable growers to attend. The 1945 meeting was held in October by necessity, and this gave opportunity for comparison of ease of attendance in fall and spring. The Executive Committee discussed the matter at some length, and agreed that while plans for the 1946 meeting were too far along to change from the spring date, the Society would be well advised to hold future meetings in early autumn. When the question was placed before the Society, the vote was almost unanimous for this change. The 1947 meeting, therefore, will be held in the fall. The exact time and place were left to the discretion of the Executive Committee.

## ANNUAL DUES

Another important change was in the dues. For many years these have been kept at \$2 per member, and in recent years it has been possible to publish the Proceedings only by the generosity of a large number of members who took Sustaining memberships for them-

selves or their firms. Increased costs of printing make it imperative to increase the dues, and on recommendation of the Executive Committee the Society voted to raise them to \$3, beginning with 1947. Even this increase will hardly suffice to pay for printing the Proceedings unless the membership increases further.



*Text of Addresses*  
*Delivered at*  
*58th Annual Meeting*  
*Florida State*  
*Horticultural Society*





# PRESIDENT'S ADDRESS

FRANK M. O'BRYNE

## *Lake Wales*

The saying that a poor beginning means a good ending applies with unusual force to the present citrus fruit season. A year ago we were in the midst of one of the most serious and prolonged droughts of which we have any record. Over fifty percent of the young fruit, which resulted from the large bloom in February 1945, shed, and quite a few trees, which had been damaged by two hurricanes in a year or were weak from some other cause, gave up the struggle and died.

Then, June 23rd, we had a regular cloudburst and in the next thirty days we had thirty inches of rain—half of a normal year's rainfall. This resulted in the largest summer bloom of which we have any record. Roughly, 60 percent of our orange and grapefruit crop and fully 80 percent of our tangerine crop resulted from this late bloom.

We started to worry about the quality of this late bloom fruit. Would it be bad or good? We now know that the late bloom Hamlins were better than they generally are, but still "nothing to write home about" on the average. Late bloom Pineapples, Valencias and other oranges were of very good quality, while late bloom tangerines were wonderful—better by far than the early bloom this season. But late bloom grapefruit, both seedy and Marsh, were a distinct disappointment. They were thick and coarse skinned, and "sheep nosed" even where there was a heavy crop on the trees—good mainly for canning.

We were fearful that with the stopping of government purchases of processed fruit for the armed forces and Lend-lease, our markets would break badly. A freeze in California and a late freeze in the North which eliminated most of the apple crop undoubtedly helped our citrus, for despite the wave of strikes through-

out the nation, the market has held up nicely. All in all, the season of 1945-46 has been a very prosperous one.

Grove values have strengthened with the strengthening fruit prices. Good groves carrying good crops have been selling for \$2,000 per acre. Extra good groves, well located, have been bringing more. Most of these sales have been made to Florida citizens and many to people who already own groves. On the whole, northerners are not responsible for these prices.

I know of a 10-acre grove which sold for \$3,000 in 1936, for \$4,500 in 1938, for \$6,500 in 1942, and for \$20,000 in 1946. At first glance you would say the owner who bought the grove for \$6,500 and sold it for \$20,000 made a wise sale. Let's see how it figures out. The sales commission was \$1,000 which left him \$19,000 so that his profit was \$12,500, a fourth (\$3,125) of which he has to pay to the government which would leave him \$15,875 to re-invest. At 4 percent interest (and he will have a hard job getting more today) this would yield but \$635.00 income per year. The grove will yield on the average between five and ten times that return during the next five or ten years. That shows why Florida people are buying the groves that are now changing hands.

That brings us to the consideration of the hazards inherent in our industry. They are many and varied. There is the weather. We have had devastating colds in the past. We will have them in the future; so likewise, with droughts. Then, there is the matter of competing fruits. The greater the supply of competing fruits, the lower citrus prices are apt to be. Then, there is competition from California and Texas. It is real competition! Citrus production is increasing the world over—Spain, Palestine, Brazil, Argentina, etc. The greater the supply of citrus, the lower will be the demand. Then, there is the matter of



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economic conditions. Groves are not profitable during a depression. We hope sincerely that employment will remain high for there is generally an orange or tangerine in "the full dinner pail."

There is little we can do to protect ourselves against most of these hazards except droughts; but, there is another very real hazard which we face, about which we can do a great deal. I refer to the danger of introducing insect and disease pests from foreign countries.

Everyone should pay a visit to the Pan-American airport while here. There are more planes and more passengers from foreign countries arriving at this airport than at any other in the world. Some days as many as 67 different planes from foreign countries land at the Miami airport alone. At present 332,000 persons per year are entering Florida from foreign countries. Anyone of them might bring in some new or serious insect pest or disease in his baggage or pockets.

I urge every member of the Society to hear the talk by our Plant Commissioner, Hon. A. C. Brown. I want to point out a few pertinent facts because some twenty years ago I was connected with the Plant Board for ten years. First, we are just entering the air age. Foreign travel into Florida is certain to increase by leaps and bounds. Second, air travel is fast. A man can get onto a plane on a rainy day in a foreign country and the clay will still be sticking to his shoe soles when he steps off onto the sands of Florida. Third, a pest of little consequence in another country may hold the most serious threat to plants in this state. For example, the Japanese didn't know they had citrus canker until it began to "go to town" in Florida. Such instances can be multiplied dozens of times. Fourth, it is far cheaper and safer to keep pests out of the state than to eradicate them after they have been introduced. Fifth, Florida has been most successful in its eradication campaigns, notably with citrus canker, black-fly, Mediterranean Fruit-Fly, etc. What we have done before, we can do again if we have to. We

have the men who know how, and a favorable geographic situation. Sixth, the success of an eradication campaign depends on detecting the pest before it has become firmly or widely established.

It is for these reasons that Florida growers must see to it that the grove inspection department of the State Plant Board is kept at top efficiency. I agree that we should strengthen our Plant Quarantine law and our Quarantine Inspection Force and investigate pests in foreign countries. When some pest gets by, as it surely will in time, we will need a second line of defense badly, and that is the Grove Inspection Force. Let us see that it is kept at top efficiency.

There is a danger connected with the interest in aviation against which we should guard. I refer to the tendency for new towns to have themselves designated "ports of entry." As indicated, each port of entry is a danger spot where foreign pests may be introduced. If a new pest is introduced at Miami or such seaport, it can only spread in a semicircle but if introduced at Orlando or Lake Wales, it can spread in all directions. There is an effort being made at Lake Wales and a number of other inland towns to become ports of entry by air. From a horticultural point of view, it would be most unfortunate if these efforts should succeed. We need fewer ports of entry in our state, not more! I urge all the members of the Society to give this important matter their earnest consideration. Think the matter through; then act.

At our last meeting this Society passed a resolution instructing its officers to call a meeting made up of representatives of all of Florida's citrus organizations to provide ways and means for sending scientists to South America to study the "Tristeza" disease of trees budded on sour orange stock. This meeting was held in Orlando, October 31, 1945, and resulted in the following committee being appointed:

Charles H. Walker—Bartow; representing Producers Trade Association.

Thomas W. Bryant—Lakeland; represent-

ing the Florida State Board of Control.  
Arthur C. Brown—Gainesville; representing State Plant Board.

H. B. Snively—Lake Hamilton; representing Florida United Growers.

Charles A. Stewart—Auburndale; representing Florida Citrus Commission.

James C. Morton—Auburndale; representing Florida Farm Bureau.

Frank M. O'Byrne—Lake Wales; representing Florida State Horticultural Society.

This committee had a meeting with Governor Millard Caldwell in Bartow on November 19, 1945. Several of his Cabinet were present. Dr. A. F. Camp made a report on the disease and estimated that the cost of buildings, salaries and other necessary expenses for a year's investigation would approximate \$60,000. The hope was expressed that Texas might supply \$20,000, California a like amount, and Florida the balance. Thomas W. Bryant expressed the concern of the Board of Control and said that it was willing to send Dr. Camp to California and Texas to present the matter and solicit their cooperation. Governor Caldwell expressed himself as thinking we were wise to study this disease in the other country rather than wait until it was established here before starting our study. He assured us of his support when we knew how much money Florida would have to furnish. Charles H. Walker said that the study should be made even if Florida had to finance the entire venture alone. There was an unanimous agreement that the citrus growing states should direct and finance most of the investigation.

Dr. Camp made his visit to California and Texas just before Christmas. We know that he presented the matter well; he always does. After considerable discussion and the exchange of a number of letters, the California State Board of Agriculture passed a resolution asking the United States Department of Agriculture to undertake the investigation of Tristeza. They regretfully declined to help financially. Texas citrus growers are not as well organized as they are in either California

or Florida and their citrus area is but a small spot in a very large state, but 99% of their citrus trees are on sour orange stock and they are deeply concerned. They do not feel like asking the U. S. Government to assume a task that they feel they should have a more direct connection with, and they feel that Dr. Camp is the man to head this investigation. Under the able leadership of Mr. E. M. Goodwin of Mission, Texas, the Texas citrus growers are raising their share of funds by voluntary contributions from the industry. As soon as we know definitely how much of the expense Florida is to bear, we will undertake the task of raising it. Meanwhile, we understand that Dr. Camp has located an investigator who speaks Spanish and who is willing to take charge of the investigation.

It has been our plan from the start to ask the U. S. Department of Agriculture to investigate the possibility of its being a virus disease since they believe that it is and they have already started a study of root stocks to find what stocks can be substituted for sour orange, should that course unfortunately become necessary. Every effort will be made to see that there is no overlapping of effort in this investigation. We need to know *how* the disease is spread and *against what* we should quarantine, and we need that information now. We expect to continue our efforts until the investigation is completed.

Most of you are growers of many years standing. You can remember when citrus growing was a hard game and groves were a drug on the market. In recent years groves have been much more profitable, and grove values have strengthened. Groves that sold a few years ago for \$500 per acre are now being purchased by grove owners of many years experience for \$2000 per acre and up. Let us not "go to sleep at the switch" and let some pest come in and ruin these values as in the days of canker and Medfly. Let us also push forward our investigations of canning and processing citrus and developing by-products so that grove values may be sustained despite our rising production.

# BAYARD F. FLOYD COMMEMORATION

RALPH L. MILLER

*Plymouth*

In 1917, twenty-nine years ago, BAYARD F. FLOYD was made secretary of the Florida State Horticultural Society. During this time he thought first, last and always about the horticultural development of Florida and those folks engaged in it.

His ability to select speakers and papers for programs for these almost 30 years was particularly outstanding. His secretarial duties became so natural and so well developed that he could arrange and execute a program most successfully without any complaint, remarks, or any obvious effort.

He had an excellent sense of humor and we know that if he were able to look in on some of our meetings without him and see the difficulty we have getting some of the work done, work that he did without any apparent effort, he would get a good laugh out of it.

The COLONEL, his most common nickname, had an opportunity of watching Florida horticulture develop for more than a third of a century. He originated successful programs during wars, booms, depressions, high prices and low prices, freezes and dry weather, floods, gas and tire rationing, and many other restrictions and difficulties. He made no complaints. He enjoyed it and did it well.

The COLONEL was not only a student of Florida horticulture but also an excellent student of human nature. He understood the horticultural problems very well, but probably understood the workers even better. He no doubt knew more and talked less about folks in Florida than any one you have ever known. He always had a pleasant word and

smile for everyone, was thoughtful, considerate and generous. He was untiring in his efforts for his friends and he had no enemies.

If each of you will stop and quietly recall some of your contacts with the Colonel you will remember only pleasant experiences. If you will recall some of his conversations you will be reminded that you have learned much from him. If you will stop to consider some of his recommendations you will realize that his good advice has benefited you greatly.

This is the first meeting for almost 30 years that he has not arranged and he had made many specific suggestions for this one. This is the first meeting for almost 40 years, except for one when he had the "flu," that he has not been present. The COLONEL'S physical presence is gone—gone suddenly and forever. We all knew him, knew him well and we have an opportunity and obligation to carry on his ideas and suggestions, improved by additional developments, as well as continue his friendly, easy manner of conducting the Society's business.

It was the COLONEL'S idea that this should be a good-time meeting. He said folks had been suppressed by war and other things for so long that they wanted a good time; so let's have it. We have excellent speakers and interesting papers and we want to hear all of them. A most complete program of entertainment has been arranged too, and it was the COLONEL'S wish that we enjoy that also.

We want to dedicate this meeting to the memory of Col. Floyd. May we all strive to carry on and improve as he would want the Florida State Horticultural Society to the best of our ability, and may the spirit and the enthusiasm of the COLONEL live on and on and on.

# FLORIDA HORTICULTURAL RESEARCH

HAROLD MOWRY, *Director*

*Florida Agricultural Experiment Station*

Florida with its vast commercial acreages of vegetables, fruits, nuts and flowers, coupled with its wide variety of plants grown as ornamentals for beautification or aesthetic purposes, has attained a highly specialized and yet diversified horticultural leadership. The state's agricultural income is preponderantly from its numerous horticultural products which account for something like three-fourths of the total return from all agricultural activities. The per-acre income from these crops compares most favorably with that of the high-bracket income farming areas of the nation.

Paradoxical as it may at first appear, of this state's great number and variety of horticultural crops now cultivated commercially, only one, the blueberry of the extreme northwestern counties, is a native Florida plant. Unlike some South American areas which lost the production of their own native rubber and cinchona to the Far East, and Mexico its vanilla to Madagascar, Florida has not lost to other areas but instead has obtained its cultivated crops from almost worldwide sources. Some examples would include:

The potato, by way of Europe, from Peru, Bolivia and Ecuador;

The pineapple from Paraguay and southern Brazil;

The guava and avocado from Mexico, Central America and northern South America;

The bell pepper from Central America;

The citrus fruits mainly from the Orient by way of Europe and the West Indies;

The watermelon from Africa, and many vegetables from the Old World;

The tung tree from China; and

Gladiolus from Africa and the Mediterranean.

The successes attained in Florida with these and other plants of foreign origin are probably best demonstrated by citing a year's total packed value of some horticultural crops. For the 1944-45 season this value was over 200 million dollars for citrus, 8 millions for non-citrus fruits and over 92 millions for vegetables. The figure does not include the several millions derived from pecans, tung oil and commercial ornamentals and flowers. For outstanding food production, mostly horticultural crops, the United States Department of Agriculture bestowed the Agricultural "A" award on four Florida counties and 14 Florida food processing firms. Production has steadily been increasing; the 100 million box citrus crop is not far in the future and the state ranks first of the Southeastern States in vegetables grown.

All of this introduction, adaptation and production didn't just happen of its own accord. Although Florida's discovery was in the year 1513, it has only comparatively recently attained its enviable horticultural standing. Its sandy soils are not noted for their natural fertility and plants do not always easily adapt themselves to a new environment. Seasonal conditions are different and general climatic factors militate against the success of many fruits and vegetable varieties from more temperate regions, and occasional frosts prevent the growing of many plants with tropical requirements. However, the most is being made of Florida's climate, the nearest to the tropical of any in the continental United States, and with this greatest asset has been built a huge winter vegetable and flower industry and the world's greatest citrus area.

No small part of these successes is due to agricultural research by State and Federal agencies, as well as by individuals, and to the alacrity with which the Florida horticulturist accepts and puts into practice research findings. It has been well said that research is

vital to the advancement and prosperity of agriculture. In no area has this been demonstrated to a greater degree than in Florida. Problems of soils, of variety adaptation, of cultural management, of nutritional requirements, and of control of an exceptional number of insect pests and diseases have had to be overcome to a large degree before the crop could be said to be a success. And with many plants, differences in soil types have necessitated special or modified treatment, particularly with respect to variety, fertilizer needs and disease susceptibility.

Perfection never has and never will be achieved. To maintain even our present horticultural status requires constant vigilance and continued improvement. To illustrate, consider the names of the major vegetable varieties of 15 years ago with those of today, as well as the nutritional practices then and now. Varieties superior in yield, quality, marketability or disease resistance have replaced a large number of the "best" ones of that day. For example, in potatoes the varieties Sequoia, Pontiac and Sebago largely have taken the place of the older varieties with progressively heavier and more satisfactory yields. Celery plantings have profited by the introduction of the Pascal variety. Introduction and breeding of tomato varieties resistant to nailhead rust and wilt have prevented the former heavy losses from these diseases and an extensive breeding program is producing varieties having needed characteristics. Watermelon wilt is being overcome by breeding resistant varieties as is also the Phomopsis blight of eggplant.

Introduction of the Tendergreen bean filled a definite varietal need as has also the development of the Florida Belle. A new round-podded bean, the Dixie Belle is just being released and it appears to be a valuable addition for the Everglades region. The Station is cooperating to the fullest with the U. S. Vegetable Breeding Laboratory at Charleston, and annually tests and selects from numerous vegetable varieties and strains as they become available. In the vegetable in-

dustry particularly, its maintenance more than ever will require continuous plant breeding, selection and comparative trials for still better disease resistance and other qualities.

Hand in hand with varietal phases there must be improvement in cultural and nutritional practices as well as of insecticides and fungicides and their application. The newer organic fungicides, insecticides and nematocides offer specialized controls not heretofore satisfactorily attained. This is exemplified in the highly satisfactory results on the late blight of potatoes and the very encouraging preliminary tests which indicate that a new control has been found for the mole cricket and the corn earworm.

Some of the minor elements have been of immense benefit to vegetable production in some areas, as manganese on the marls of the lower East Coast, copper in the Everglades, and boron on celery in the Sanford district.

The program incorporating the use of minor elements has resulted in revolutionary changes in the cultural practices in the State's citrus acreage. Copper, zinc, manganese and magnesium are now regularly included among the nutritional elements supplied, with boron and iron entering where needed. This program has been responsible for the overcoming of various types of lack of thrift, together with chlorotic foliage conditions. General appearance and thrift of trees has been markedly improved and fruit yields appreciably increased without the increase in application rates of regular fertilizers. Fruit quality has been improved in texture, color, increased solids and raised Vitamin C content. The minor elements have vastly bettered tree condition, added cold resistance, increased both yield and quality, and at the same time have lowered the per-box production cost.

Tung oil, the latest of the tree crop introductions, will yield from the last season's crop a gross return of nearly one million dollars. Under Florida conditions the successful culture of this tree would have been a dismal failure without the determination and

supplying of its nutritional requirement for zinc.

New type wrappers for both citrus fruits and vegetables have been thoroughly tested. These offer the probability of reduction in transit losses and of improved storage and keeping quality and should shortly be available in sufficient quantity for commercial use. Definite progress also has been made in the control of citrus fruit decays developing in transit and storage.

The foregoing examples are but a limited few of the horticultural researches in Florida. A total of some 107 projects, some cooperative with the U. S. Department of Agriculture or other Federal or State agencies, are conducted on horticultural subjects at 5 stations and 7 field laboratories of the Florida Agricultural Experiment Station. The Federal-State Frost Forecasting Service is a cooperative undertaking between the U. S. Weather Bureau and the Station. Projects on fruits, vegetables, nuts and ornamentals include the many phases in the fields of culture, variety and plant breeding, control of diseases and injurious insects, soils and soil fertility, economic studies, wrapping, package and storage, utilization of by-products, and several types of processing. The last will be measurably increased with the availability of facilities. It is anticipated that both the experimental citrus and vegetable processing plant buildings, as provided by the last Legislature, will be completed and the work under way during the coming season.

The highly complex problems of the horticulture of today require not only research in production but its extension into harvesting, handling, packing and packaging, transportation, storage, processing, marketing, economics, and utilization of by-products. This in turn has made necessary a realignment in research methods and procedure. Research workers with competent training in the several technical fields are the first essential, but the day for the most part is gone when an individual investigator operating alone can secure the whole of the wanted results even in his own field. The present trend is toward a group

attack on a problem wherein the combined efforts perhaps of several highly trained specialists are cooperatively joined in a single project. For example, the services of a plant physiologist, a biochemist, a soils chemist, a plant breeder and a plant pathologist might be required and utilized to overcome a soil-borne disease or one affecting shipping or marketing of a given product. Such combinations make for much more complete and earlier results.

A great number of the problems encountered require a wide array of the highest type and most modern scientific equipment and facilities as well as a knowledge and familiarity with the required techniques. As such, there is no single agricultural science; it is a combination and application of basic physical, chemical, biological and mathematical sciences requiring both the well-equipped laboratories and the field to obtain the final practical and usable result. Much has been heard of the atomic bomb but little of other applications of atomic energy. In our laboratories, radio-activated elements are being used in animal nutrition studies, and recently similar studies with plants have been inaugurated whereby a chosen element, phosphorous for instance, can accurately be traced and measured to the millionth part as it moves or is deposited in the tissues. This adaptation of atomic physics opens a new field in physiology and offers the probability of extending our knowledge of the role of various elements in nutrition.

Numerous recent developments have opened avenues of approach to better or different methods of meeting production and other agricultural problems. Wartime advances in meteorology will prove of value in the advancement of dependable long-range temperature forecasting. New chemicals and equipment are assisting in pest and disease control. Tests have been made on the adaptability of the military "fog" generator as a means of applying spray materials, and a mist derived mechanically may be valuable for the same purpose. Airplane applications of dusts for insect

or disease control apparently may be extended to sprays, and application from the air of fertilizer materials for suitable situations also may be extended to other than the minor elements. Air transportation is to be considered for some Florida produce, but it should not be overlooked that the airplane is a means of a quick ride, not only for man but also for unwanted pests and diseases and possibly for

some stiff market competition from areas now given little consideration.

Florida has been both wise and generous in its provision for agricultural research. The staffs of your agricultural experiment stations recognize the obligation and responsibilities imposed and will continue their efforts to the utmost in the improvement and advancement of the state's widely diversified agriculture.

## THE SIGNIFICANCE OF WATER CONSERVATION IN THE AGRICULTURAL DEVELOPMENT OF SOUTH FLORIDA

R. V. ALLISON

*Everglades Experiment Station*

Belle Glade

The importance of water control and conservation in the development of South Florida's agriculture, as well as several other very important aspects of the economy of this section of the State, has been so much emphasized and so frequently reviewed during the past few years that a further discussion of the subject at this time would be without very much point except that, during recent months, things have begun to happen down here, so to speak.

Before reviewing for you some of the things that have happened and are happening, however, let me remind you that they have not just decided to come about of their own free will and accord. First of all there is the great, driving interest of the Governor and his entire official family in Tallahassee, who probably have this problem of water conservation more constantly before them than any other single consideration that could be mentioned at this time.

There is also the urgent interest of each and every member of the Board of Commissioners of the Everglades Drainage District,

who, under the fine leadership of Chairman Hilsabeck, are using this questing of water handling and conservation as a veritable pivot around which each and every thought and plan pertaining to any phase of the general program of the District is obliged to turn for official scrutiny.

In a more local way mention also must be made of the splendid efforts that are being extended by the Resources Development Board of Palm Beach County under the untiring leadership of President P. P. DeMoya and Manager R. J. Blank in the direction of organizing local maintenance units for a more effective handling of water supply problems. The first two units by way of a trial effort, are being established in the areas to be served by the West Palm Beach and Hillsboro Canals as the plans develop for the further improvement of these two important arterials. Right in this connection I wish I could tell you of the fine hearing pertaining to flood control and navigation on these two canals that was held this afternoon in Belle Glade under the sympathetic supervision and chairmanship of the District Engineer, Col. A. B. Jones. The need for effective flood control in this important agricultural area for the protection of a number of thriving communities as well as crops, livestock and other

vested interests was very strongly urged, the scale and nature of some of the principal works as well as the purpose which they are to serve being presented as forceful argument for the active participation of the U. S. Engineers Corps in the planning and development of the over-all program. Aside from testimony given by a large number of individual growers and organizations, a preliminary draft of the plans for the Hillsboro and West Palm Beach Canal Units was presented by Everglades Drainage District Engineer Lamar Johnson for review and study by Col. Jones and his staff. The support of a large percentage of the landowners in each of the proposed maintenance districts for these plans was presented to Col. Jones in the form of a resolution from each district, asking for the active guidance and help of the Federal Government in the broader flood-control phases of the program for both areas and pledging whole-hearted assistance in the development of such plans as may be formulated.

In briefly reviewing the current progress that is being made in the solution of the water-conservation problem in South Florida, mention also must be made of the effective cooperation that has developed between Dade County Authorities on the one hand and Officials of the Everglades Drainage District on the other, in which the whole question of municipal water supply is being clearly and effectively analyzed and studied. That progress is being made is best indicated by the fact that both agencies are looking at both sides of the question, namely, municipal requirements and agricultural values. When this sort of approach is used and the effort is held on an earnest, purposeful basis, it is practically certain that a solution will be reached which will be satisfactory to all concerned.

#### SOIL CONSERVATION

There can be no doubt in the minds of any who are at all conversant with the general problem that the greatest significance of water control and conservation from the

agricultural standpoint lies in the conservation of our soil, since it is only through the most judicious use of practically all the water that is available throughout the year that this can be accomplished to any worthwhile extent. Naturally if we do not conserve our organic soils to the very best of our ability we do not have much of a basis for discussing their place in the long-time agricultural development of this section of the state.

Occasionally we are asked why we have waited so long to stress the soil conservation problems in the Everglades. Our simplest reply is to refer to the first bulletin, Fla. Expt. Station, No. 190, published by the Everglades Station in 1927, from which I quote as follows:

"One of the most important problems from the agricultural standpoint of peat soil in general is that of shrinkage and excessive drying as a result of drainage. If the Everglades is to develop into a durable agricultural project more importance should be placed upon this than any other single consideration.

"In order adequately to protect peat soils against fire and conditions of excessive drought, absolute water control will be necessary and this should be the aim in starting an agricultural development of this nature. In the case of excessive drought, even in the absence of fire, such conditions tend to accelerate natural oxidation processes and result in a further net loss of the material.

"From this standpoint in particular the whole project is not a problem for the engineer alone. It is rather one in which agricultural research must play an important part in developing systems of cropping and rotation that will coordinate with the condition and movement of the water table in such a way as to afford maximum protection against this loss. To those who have a broad, sincere interest in the development of this area as a state resource, the matter of subsidence and water control can not be over-



emphasized. Indeed, we have need but to refer to the experience of the English upon the Fenland of that country where, with time, strata of peat several feet thick have almost disappeared and drainage lines and cultivation are now largely in the clays with which the peat was formerly underlaid. Since the peat soils in the Everglades area are underlaid with limestone rock or by sand over lime rock, the need for caution in their unnecessary exposure is readily seen."

That there is grave need for soil conservation measures of the most heroic type in the Everglades area in particular is fully indicated by the physical fact of soil dissipation under present conditions of handling, which is becoming so grossly apparent that it no longer can be conveniently ignored. Thus in certain sections of the upper Clades we have records to show that the surface elevation of the land is from 4 to 6 feet lower than it was in 1914. While a certain percentage of this shrinkage in the soil mass and consequent surface subsidence was unavoidable in bringing land of this type into cultivation, a quite considerable part of it would have been prevented by a more careful handling of the water table in and on the land in the interest of slowing down natural oxidation and preventing open burning, which has occurred much too frequently in the past.

This whole question of soil conservation in relation to our organic types has been so fully covered in two recent volumes of the Proceedings of the Soil Science Society, IV-A (1942) and V-A (1943) that it should not be necessary to go into it at this time except in a very general way.

In the first place the thorough geological studies of this extensive area that have been quite fully reported in the above volumes show very clearly why our water control problems become more difficult as we move southward down the peninsula from Lake Okeechobee. Thus as we pass from the comparatively tight Fort Thompson formation onto the highly porous Miami oolite or onto the even more permeable Tamiami limestone,

which serve as foundation material for what is left of the original blanket of peat, we encounter an entirely different and much more difficult condition under which to control water levels, due to the natural inability of these types of rock to hold water against seepage. As a matter of fact it is probable that this highly permeable condition in the supporting formation has been as responsible as any other one factor for the much shallower depth of organic material that has developed over this whole southerly section of the Everglades, due to the substantially lower average stage of the water level that has been maintained through the centuries during which the deposit of plant material has been laid down.

In any event recent surveys have shown vast areas of peat land to the south to be so shallow in depth, as the result of failure in the original formation or due to subsequent burning, as to be very largely without value from the agricultural standpoint. This, of course, should not be taken to mean that some one could not set up a temporary operation on some section of this extensive area and succeed with a short-time crop or two while the water table happened to be satisfactory for the purpose. It does mean that the soil is too shallow and the rock too porous to justify the cost of putting in extensive water control facilities on either large or small areas, which would require several years of normally successful operation to amortize but which could not possibly be successful in protecting the investment against either excesses or deficiencies of water. It is this type of area which we are looking to as storage basins for water and the development of wildlife refuges.

The trends of soil dissipation and subsidence in the Everglades are serious enough on the best of our lands to challenge everything we can put into an effort at prevention or even of substantially slowing down. Only recently I was asked by a correspondent from South Florida regarding this soil conservation trend on organic soils and my reply was that it constituted one of the most perfect

examples that could be found anywhere of the old saying to the effect that "you can't eat your cake and have it too." In this instance the paraphrase would suggest that you can't farm this type of soil and keep it indefinitely under any circumstances, though the manner in which the farming is done, especially with respect to the handling of the water supply, will most certainly determine how fast the soil will disappear. That is to say, with a proper handling of the water supply the life of these soils can be very greatly extended. This subsidence trend is very well shown in the graph of Figure 1 which not only clearly indicates the trend of surface subsidence since 1914 at a certain point in the upper Glades but also the depth of muck remaining in relation to a proposed, practical

depth upon which agricultural operations would be feasible and sound. The photograph of Figure 2 shows at a glance the hard facts of surface subsidence at a point quite close to the profile from which the data for the graph of Figure 1 were obtained.

The recently completed soil, geologic and topographic surveys which have been carried out cooperatively by the Soil Conservation Service and the U. S. Geological Survey with the Florida Experiment Station, and which are now being prepared for publication in the form of a fully integrated report, are the most important facility that has been provided to date for use as a physical basis for planning a broad, comprehensive water-control program for South Florida. In these surveys we virtually have a series of portraits of this

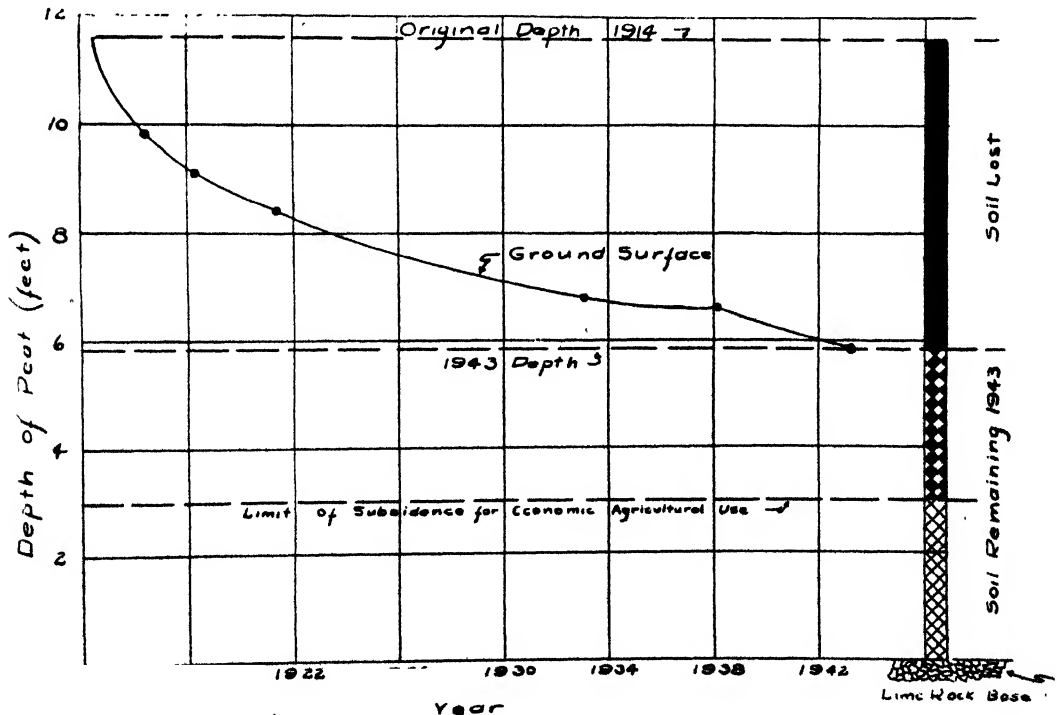


Figure 1. Graph showing rate of surface subsidence on Okeechobee peaty muck since 1914 at a location about four miles south of South Bay. The rather sharp, downward trend during the last few years of record is presumably due to increased cultivation as well as the occasional fires that took place during the interval of those measurements.

section of the state which will be found practically indispensable to any and all types of planning having to do with water control or the use of the land.

Thus through the soils map that is based upon the field work of the soil survey, we will know for the first time what soils we have, where they are, and how much of each type there is. Through this map, when available, we will doubtless find that we have upwards of 1/4 million acres, perhaps more, of excellent mineral soils of the Davie fine sand and closely related types which would be admirably suited to citrus and a number of other tree crops, if and when needed, with

obvious temperature and moisture advantages; that is, if water-conservation practices are planned and executed in accordance with the general requirements of the vast area of mineral and organic soils lying within the Everglades system.

While our mineral soils in this section of the state also offer great opportunities for pasture and livestock work and the culture of a wide variety of vegetables as well as various subtropical fruits in certain limited sections, the same care and judgment must be used in the relation of all of them to water control and conservation if success is to be attained. The importance of research



Figure 2. Temporary benchwork set up at the time of the inspection trip through the heart of the Everglades which was arranged to follow (8-18-43) the Interim meeting of the Soil Science Society of Florida which was held in Belle Glade on March 17th, 1943, for a discussion of Everglades problems. This shows that the ground elevation at this point in 1914, according to the best engineering data available, was nearly six feet higher than at the time the picture was taken in 1943.

and planning in connection with the mineral soils of this section of the state can not very easily be over-emphasized, for it obviously is upon them that our agricultural production must largely depend in the not too distant future.

#### WATER SUPPLY

The question of water supply, whether for general agricultural use or for domestic purposes, has become a critical one, not merely for South Florida alone but for the entire state. Neither is the need for water control one that applies to a particular part of the year but, instead, calls for a stabilized, well regulated condition throughout the year that will be so comprehensive in its development as to give just as much protection as possible to the abnormally dry years as well as the abnormally wet years. These, taken together, usually form cycles of rainfall extending over several years. In undertaking such a program we are always confronted with opposing groups of what might be referred to as "wet" and "dry" proponents, who are ever ready to deny the arguments of the other group when they happen to be enjoying their particular end of the cycle. However, our outlook is much brighter today than ever before, in that more and more people are beginning to see the *whole* picture and are realizing that the only way to prepare for the dry end of the cycle is to do the right thing while there is water to work with—water in abundance or even in an excess—and vice versa for the wet end of the cycle. It is this basic, fundamental type of planning that the U. S. Engineer Office has in mind in the present series of flood-control and navigation hearings which are being held throughout the Kissimmee Valley and Everglades area, and I am bound to say that the amount of public interest that is lining up behind this approach is most encouraging.

In our water-supply problem over this extensive flatland area that we call "South Florida" we have really very serious need for reserve areas or supply areas other than that which might be developed by holding

Lake Okeechobee at higher average levels—places, in other words, to put water when we have too much which automatically become definite sources to draw from in times of need. This is the simplest possible alternative for dumping water into the ocean just because we have too much of it, a disposal that should be absolutely avoided except in times of real emergency.

Fortunately we have extensive areas of land in the general Everglades area which, because of their physical characteristics and underlying formations, as pointed out above, can be argued as useful for little other than reservoir or water reserve areas. Reference is to such sections as the island and slough country west of Lake Worth, Boynton and Delray which lies beyond the confines of the Lake Worth Drainage District, or extensive sections from the central part of the Glades south to the Tamiami Trail and beyond. To say that these sections are useful only as water reserve and wildlife areas is not to condemn their existence, location or usefulness in any way, for once the real value of water is appreciated they become just as important for this purpose as for any other. As a matter of fact, I have said many times that if every square foot of land in the Glades were as good as the best of any of it, we would still have to create extensive water reserves for reasons that are rapidly becoming quite painfully obvious to all of us. In other words, we permit entirely desperate water-supply situations to create themselves under present conditions by simply allowing the water to seep away for want of judicious control. Try and imagine, if you can, what our fresh-water supply would be like if we were to undertake to drain and develop for one purpose or another even one-half of the total area of what we refer to as the Everglades. The situation would immediately become much worse than anything we have ever experienced and definitely block future development of many kinds toward which we are looking with such great expectations at the present time.

The fact that we do have extensive areas of soils that are definitely inferior from the

agricultural standpoint thus doubtless saves us from many a headache in trying to decide which areas should be used for water reserves or drainage areas and which for agricultural purposes. In spite of all the worry that has gone before, there is real pleasure to be found in all this effort at planning, in that the proper, over-all handling of our water resources along the lines that have been so much discussed in the past has several advantages, a whole circle of advantages, in fact—besides soil conservation and stabilized sources of municipal water supply. Among them is, of course, a constant source of irrigation water of which such important an agricultural area as the Lake Drainage District, to mention only one, has been urgently in need for some time. Fortunately the location and distribution of the water-reserve or drainage-basin areas that have been proposed are such as to work in very well with practically every one of the several benefits and advantages arising out of this broader handling of the entire area that are referred to in this discussion.

#### AMELIORATION OF WINTER TEMPERATURE

For instance, much has been said about the influence of exposed bodies of shallow water, such as would be involved in these reserve areas, upon winter temperatures. Although no very adequate studies have been made of this influence we have, nevertheless, quite a considerable amount of evidence to indicate that this effort may not only be worth while but perhaps very much worth while.

Thus in early March of 1932, when Lake Okeechobee was being held very low for the convenience of construction work on the levee and the water in the open Glades was at least 18 inches below the surface of the land, air temperatures fell as low as 9 degrees F. and some instruments went as low as 6 degrees F. at a point about 15 miles out in the Glades, known at that time as Shawano Plantation. The local circumstances surrounding these readings were a dry, highly fibrous top soil with a deep covering of dead weeds and grass that had been killed by

earlier frosts. However, at the Everglades Experiment Station on that same night, a location that is about ten miles nearer the Lake and in the midst of a moderately extensive cultivated area, readings of 30-32 degrees F. were recorded. At another time, when the same cultivated area more remote from the lake was surrounded by water and a cold wave came down from the northwest, we experienced frost at the Experiment Station while the outlying area that had such a low temperature before had no frost at all.

This same general relationship is indicated by more recent observations made last winter (1944-1945) by Mr. James W. Milligan, Meteorologist for the U. S. Weather Bureau stationed in the Everglades District. Mr. Milligan's summarization of the situation is quoted herewith from his report on horticultural protection work for the season which has just been completed.

"As an example of the modifying influence of water coverage to the south, the Shawano Plantation station, fifteen miles southeast of the Lake, experienced one of its mildest seasons, the temperature reaching 32 degrees on December 1. During the same cold spell, the "warm" Bean City station, within a mile of the Lake, also recorded 32 degrees F. On January 19 the Bean City station recorded 30 degrees F., but no freezing temperature occurred at Shawano. Volunteer beans growing ten to fifteen miles from the Lake sustained no damage on January 19, while temperatures as low as 29 degrees were recorded in the warm lands adjacent to the Lake in the Pahokee area. The moderately cold Okeelanta station, six miles from the Lake, recorded no freezing temperatures during the entire season. A similar situation prevailed on the Lower East Coast, which experienced one of the warmest seasons on record, the only 32 degrees F. temperature of the season occurring on February 25, after the uncultivated saw grass lands to the northwest in the Glades had dried up."

It would seem that the above indications

are sufficiently definite to justify rather liberal expectations as to the effects of extensive re-watered tracts back in the Everglades on the winter temperatures of the Coastal resort cities; also on such important production areas along the East Coast as the Fort Pierce area, Lake Worth Drainage District and the extensive farming areas south of Miami. In any event the opinion is ventured that, in this relationship alone, there exists a benefit that may be worth very nearly as much as the entire water control program might cost, quite aside from the many other advantages accruing from the availability of adequate supplies of water.

#### WILDLIFE PROTECTION

In appraising the varied and numerous benefits arising out of an improved water-conservation program for South Florida, we should not regard its value to wildlife propagation and protection as among the least important, whether in the several areas to be devoted to parks and government controlled refuges or in the extensive hunting preserves for which Florida has become well known, most of which, however, can stand a considerable amount of improvement. In the instance of the proposed Everglades National Park, for instance, there would seem to be a very definite need for an improved water supply if we are to realize the fine purposes for which this area is to be dedicated, since wildlife can not and does not develop without a reasonable supply of food. Natural food supplies, of course, do not develop in abundance without at least a reasonable supply of water, a condition that is inseparably related, first, to holding the water on the land that falls there, and secondly, in supplementing this supply just as far as possible by overland flow from the north or by delivery thru a series of well planned canals, constructed in part for passing surplus water down to these areas.

#### CANAL MAINTENANCE

Unfortunately once a canal is fully planned and its cross section completed the problem

of its performing up to calculated capacity is only well begun. It has been realized for some time that one of the greatest enemies of water-control systems in this tropical section of the state is the profusion of natural growth that immediately starts in artificial waterways once they are developed. Among plants of this type some of the worst are the water-hyacinth and water-lettuce and some of the under-water growths such as "niggerwool," various elodeas, eel-grass and others.

During the past few weeks we have been testing a number of different formulations, all involving the hormone 2, 4-D, against the water-hyacinth at the Everglades Station and have been highly pleased with the results that have been obtained to date, as have also representatives of the U. S. Engineer Office and of the Board of Commissioners of Everglades Drainage District. More recently spray treatments by airplane have been initiated in cooperation with Officials of the Everglades Drainage District and Airspray, Inc., which have involved the construction and installation of equipment capable of giving good coverage with from 1 to 2 or 3 gallons of total application per acre.

While we would not presume that the formulation or formulations now in use on a sub-operation scale or the rate and time of treatment are the last word, it does look at the present time as if a satisfactory kill can be obtained for five dollars per acre, or perhaps slightly less, on areas where free and ready access by plane is possible. The standard or basic rate of treatment that has been adopted is that recommended by a number of manufacturers, namely, 1,000 parts per million of the chemical at a rate of about 200 gallons per acre, or its equivalent in more concentrated forms. As has been commonly found, formulations using an oil base rather than those in water solution are more effective, while applications in the form of dust seem to be the least effective of all.

It is hoped we may be able to push this work quite rapidly for the next few weeks, especially in view of the series of hearings on hyacinth eradication that has been an-

nounced by the U. S. Engineer Office in Jacksonville under the direction of Colonel A. B. Jones, to be held in various parts of the state. That for South Florida is scheduled to be held in West Palm Beach on June 12.

Regardless of when, how and to what extent this tremendously important problem of water conservation and handling is undertaken in South Florida, two needs must be simultaneously appreciated and actively met. The first of these is a comprehensive study of the problem and careful planning of procedure from every standpoint; the second is the attainment of public support, which can only be gained as the result of an active program of educational meetings conducted for

this purpose. Both are vital and preferably should be developed simultaneously. At least this is the approach that is being made in the development of the unit plans for the Hillsboro and West Palm Beach Canals in the Upper Glades; and we believe we are making progress. If successful I am confident an effort will be made to use this approach in other sections of the Glades. Certainly there is no other basis apparent at the present time for effective planning of this nature which would eventually bring adequate water supplies for every conceivable purpose so completely into the service of South Florida's multilateral development as this "all-weather" approach.

## STUDY OF QUALITY IN TEMPLE ORANGES<sup>1</sup>

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The subject of tasting tests is being given widespread attention at present in food research. The extent to which qualitative ratings can be standardized, given a quantitative interpretation, and analyzed statistically is of real interest. Recent discussions include one by Howe and Barbella (3) on meat flavor and one by Levin (4) on dried-egg quality.

The latter is similar in viewpoint to the study here reported. Fisher (5) outlines a method believed to be of great promise in dealing with personal and qualitative ratings,

but it is beyond the scope of the present study. In efforts to make such ratings more quantitative it has been found of value to limit the number of grades, to define and describe them carefully, and to check them occasionally against a standard where this is possible. These measures tend to standardize conditions for readings for all workers and occasions.

### EXPERIMENTAL PROCEDURE

The Temple oranges for this investigation were obtained from 4 experimental plots located in commercial groves at Windermere, Florida, where the soil type is Norfolk fine sand. Each plot consisted of 15 to 25 trees, and the trees of each plot were on a different rootstock, namely, rough lemon, sour orange, sweet orange, or Cleopatra. The trees were of mature age. Tests on the fruit were made at 7 different picking periods and thus included a wide range of stages in fruit development and ripening, from immaturity to senility. Picking was in the first 5 days of each month, October to April.

It will be noted that only one plot was available for each rootstock, hence the experi-

<sup>1</sup> This paper was printed with full details of data in Food Research, 1945, Vol. 10, No. 6, pages 510-517.

ment is subject to the criticism that plot replication is not provided; that we are not sure whether differences found are characteristic of rootstocks or of the plots themselves. However, the records may be used in preliminary study. The differences found in this work between fruit from different rootstocks are such as have been repeatedly noted before.

The fruit samples were taken to the laboratory at Orlando, Florida, immediately after they were picked and were placed in storage at 32 degrees F. until tested. Each sample consisted of 60 or more fruits picked from the 15 to 25 trees. The total-solids content and total-acid content were determined on the composited juice of 25 fruits. The fruits that remained were used for palatability tests.

Total water-soluble solids were determined with an Abbe refractometer. Total acid was determined by titration of the orange juice with standard NaOH, using phenolphthalein as an indicator, the results being calculated as anhydrous citric acid. Palatability was determined by the method described later in this paper.

#### FACTORS INFLUENCING QUALITY AND THE METHOD OF EVALUATING PALATABILITY

The internal quality of citrus fruit is in-

fluenced by several factors, such as total solids, total acid, ratio of solids to acid, texture of flesh, and aromatic constituents. The age of the fruit is also important. Immature fruit is usually very acid or tart and has a raw, immature taste, whereas overripe fruit held on the tree too long may become insipid or develop disagreeable off-flavors.

Throughout this investigation assays for flavor or taste were made on the fruit soon after picking. In each test 30 to 50 Temple oranges were used. The fruits were cut transversely and from each half was cut a wedge-shaped piece for tasting. Each judge was advised to taste several pieces before rating a sample according to the arbitrary scale shown in the rating form (fig. 1).

Staff members of the Bureau of Plant Industry, Soils, and Agricultural Engineering and of the Bureau of Entomology and Plant Quarantine stationed at Orlando regularly officiated as taste judges. Frequently visitors also were present, and they too were invited to score the various samples.

Thus judges available at each time were utilized, and the group was not the same every time. However, there were 8 tasters who

FIGURE 1. RATING FORM GIVEN TO THE TASTE JUDGES, WHO WERE INFORMED THAT FRUIT RATED 70 OR BELOW WAS REGARDED AS NOT MEETING CONSUMER APPROVAL

Arbitrary standard	Taste or flavor of fruit	Numerical rating range corresponding to description	Individual numerical rating
Very acid	Very acid, raw, immature flavor	20-39	
Acid	Acid, with absence of raw, immature flavor	40-59	
Tart	Too tart for consumer approval	60-69	
Pleasantly tart	Minimum stage of acceptability for consumer	70-79	
Pleasantly tart to sweet	Pleasant blend of sugars and acid, with very good texture and flavor	80-100	
Insipid (aged)	Very sweet, watery, lacking in flavor, low acidity, aged	50-100	



participated in every test. In all, 34 different men participated in one or more of the tests; 21 to 27 worked each time. Scoring was according to the scale described in figure 1.

At the beginning of the season the arbitrary standard scale to be used and the method of evaluating the internal quality of Temple oranges were discussed with a number of the staff members who were to participate as taste judges. At that time it was decided that the numerical value of 70 would be the minimum standard of acceptability and that any fruit rated below that value would be considered undesirable. On the other hand, desirable internal quality was rated 70 to 100 as indicated. The scale permitted the scoring of insipid fruit (values 50 to 100), but it was understood that any of the samples of insipid fruit that were rated below 70 would not meet consumer approval.

There were some variations among individual fruits in the samples, but generally any given sample was rather uniform in flavor. However, in scoring, each judge was advised to base the rating on the average flavor, after tasting several pieces of fruit of the lot.

#### ANALYSIS OF RATINGS

The tasters were believed to represent fairly well the prospective consumers of Temple oranges. The percentage grades given are subject to the criticism of all such ratings; they may be somewhat subjective, difficult to standardize, and hard to keep constant from judge to judge and from time to time. There may be some doubt that they fully meet the assumptions required for analysis of variance. However, every effort was made to make the ratings sound measures of acceptability, and they may well be analyzed for what they can show.

The differences between tasters proved not to be large. Hence, in Table 1 the average grades for each month and each rootstock are presented, even though the group of tasters was not exactly the same for any two months.

TABLE 1. AVERAGE GRADES GIVEN TEMPLE ORANGES BY ALL TASTERS.

Rootstock	Period of picking, during first 5 days of—						
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Rough lemon	27	55	78	91	95	94	83
Sour orange	30	58	79	93	98	96	91
Sweet orange	28	57	80	94	98	96	92
Cleopatra	27	56	81	95	98	96	92
Mean	28	56	79	93	97	95	89

Next a study was made of the ratings by the eight judges who worked in every period. The average rating for all four rootstocks by each of these tasters in each month was determined.

The results from these eight, when averaged, were very close to those of the larger group shown in Table 1. These results gave a balanced table making possible the use of detailed analysis of variance.

#### LABORATORY DETERMINATIONS

Acidity and solids were determined as described and are presented to show their general trends.

TABLE 2. TOTAL-ACID (AS ANHYDROUS CITRIC ACID) CONTENT OF TEMPLE ORANGES. WINDERMERE, FLORIDA, 1943-44.

Rootstock	Picking Periods						
	Percent						
	Oct. 1-5	Nov. 1-5	Dec. 1-5	Jan. 1-5	Feb. 1-5	Mar. 1-5	Apr. 1-5
Rough lemon	2.65	1.80	1.31	1.01	0.85	0.77	0.63
Sour orange	2.68	1.88	1.45	1.07	1.02	0.83	0.77
Sweet orange	2.49	1.79	1.36	1.09	1.00	0.93	0.76
Cleopatra	2.63	1.75	1.35	1.06	0.93	0.82	0.71

TABLE 3—TOTAL-SOLIDS CONTENT OF TEMPLE ORANGES. WINDERMERE, FLORIDA, 1943-44.

Rootstock	Picking Periods						
	Oct. 1-5	Nov. 1-5	Dec. 1-5	Jan. 1-5	Feb. 1-5	Mar. 1-5	Apr. 1-5
	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Rough lemon	7.57	8.70	9.37	10.05	11.38	11.87	12.12
Sour orange	8.72	9.40	11.17	11.70	11.93	12.71	13.32
Sweet orange	7.98	8.90	11.57	11.65	12.23	13.36	13.42
Cleopatra	7.98	9.25	10.87	12.04	12.58	13.41	14.07

Analysis of variance was used in study of the acid and solids determinations, separating variance for rootstocks, periods, and interaction.

Rootstocks showed only very moderate differences in solids and acidity, though with the consistency shown they appear significant. Both solids and acidity differed markedly from month to month.

#### CORRELATION WITH PALATABILITY

Both acid and solids readings were correlated with the palatability grades, using for the latter the average of all the 8 tasters participating in every test. Since the set of 28 readings was classified by periods and rootstocks, the correlations were determined from covariance analysis, showing the relations in the different classifications.

The correlation of both solids and acid with palatability is almost altogether due to the month-to-month changes. The linear correlation with solids is lower than that with acids, although it seems more definite in agreeing with observed tendencies of rootstock difference. The correlation of solids and palatability, between rootstocks, reaches significance without much to spare. The acidity correlation between rootstocks was in the reverse direction from that between periods, and did not reach significance. No correlation was found in the interaction classification; nearly all variation is associated with period and rootstock.

Palatability ratings show a close negative association with acidity in the month-to-

month change, but not between rootstocks. They show a close positive association with total solids, both as between months and between rootstocks. In the month-to-month correlation the relation is apparently a curved one, a peak of palatability coming between 12 and 13 percent solids. The computed maximum of the curve is at 12.4 percent solids.

#### CONCLUSIONS

Palatability ratings of Temple oranges show a marked seasonal trend, palatability rising rapidly through the late fall and early winter, reaching a peak in late winter, and dropping off a little in early spring. It is concluded that differences between rootstocks were not marked, but there was indication of some inferiority in rough lemon. Tasters showed differences, but not large ones. Acidity and solids showed marked seasonal trends, the former decreasing, the latter increasing; and rootstocks gave only moderate differences in acidity or total solids of the fruit. Palatability was highly correlated with both acidity and solids. The relation between palatability and content of solids seemed more consistent than the palatability-acidity relation, and could be represented by a curved graph, palatability increasing with solids up to about 12½ percent and falling off with further increase of solids. Some features of analysis indicate difficulties in securing objectivity in the ratings. The definite association between palatability ratings and some more exact measurements indicates, however, that the ratings are rather satisfactory in measuring quality.

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## SOME FACTORS INFLUENCING CITRUS FRUIT DECAY EXPERIMENTS

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It has been known for many years that the principal storage decays of Florida citrus fruits are the stem-end rots and *Penicillium* molds. The taxonomy and morphology of the causal organisms *Diplodia natalensis* Evans, *Phomopsis citri* Fawc., *Penicillium digitatum* Sacc., and *Penicillium italicum* Wehmer have been very thoroughly studied. Some facts have been discovered about their physiological requirements in relation to their host but essentially nothing about their actual control from a commercial point of view. While much experimental work has been done in previous years, there appears to be at the present time a greater interest in the problem. This is perhaps due to better organization in the citrus industry and to a greater realization of the economic importance of losses caused by stem-end rot and *Penicillium* molds. High market values of citrus fruits may also be a factor. The recent discovery of Childs and Siegler (1, 2) that treatment of the fruit with a solution of thiourea is very effective in preventing rots and molds has served to further stimulate investigations in this field.

For the past 3½ years the authors have carried on extensive experiments for the purpose of developing practical methods of decay

control for use in packinghouses. In the course of their investigations it became evident that before the effect of a treatment, either chemical, mechanical, or otherwise, could be evaluated, some means must be devised whereby the results of their experiments could be correctly judged. This was imperative because of the fact that fruits from the same tree varied in their response to decay. It was found that fruit from different sources, especially between magnesium-deficient trees and those well fertilized with this element, varied considerably in their natural amount of decay. Fruit from different varieties or from different groves having the same cultural treatment, all showed wide variation in the amounts of decay which developed when held at comparable storage conditions (3). Then, too, the temperature and humidity of the storage rooms appeared to be a factor in the amount of decay which developed. All of these factors tend to make it very difficult to interpret satisfactorily the results of any given experiment unless it is designed in such a way as to evaluate the degree of natural variation that is occurring in the fruit and over which there is no experimental control. Fortunately there are methods of designing experiments in such a manner that this variation may be estimated. One of these methods, known as the analysis of variance (7), has been used during the past two years or more to evaluate the results of the most of our experiments.

Analysis of variance for a typical experi-

<sup>1</sup> Work done at the Citrus Experiment Station, Lake Alfred, on funds provided by the Florida Citrus Commission, Lakeland.

ment is given in Table 1. In each treatment 100 oranges divided into 4 lots of 25 were used and the number of decayed fruits in each lot recorded. In treatments 2, 4, and 6 thiourea was applied in different ways and the fruit processed in the packinghouse machine. Treatments 3, 5 and 7 correspond to 2, 4 and 6 respectively, but were given a more thorough rinsing with warm water after the washer. Number 1 is the untreated check. This analysis shows that there was a significant reduction in decay caused by all of the treatments with thiourea when compared with the check. It is also evident that more thorough rinsing after treatment 2 (i. e. treatment 3) did not increase the amount of decay, while for treatments 4 and 6 this was not true. The increases from 1% to 14% and from 3% to 13% are significant if the 5% level of probability is taken, but scarcely significant if as high a certainty as the 1% level is desired. The corresponding least difference necessary for significance at the 1% level would be 10.2% instead of 7.6%.

TABLE 1—SHOWING THE NUMBER OF DECAYED FRUIT WHICH OCCURRED IN EACH LOT OF 25 AND THE VALUES FOUND BY ANALYSIS OF VARIANCES.

Trials	Treatment						
	1	2	3	4	5	6	7
A	10	0	0	0	5	1	4
B	9	1	1	0	2	1	3
C	5	0	0	1	5	1	2
D	10	1	2	0	2	0	4
Sum of decayed fruit	34	2	3	1	14	3	13

Source of variance	Degrees of freedom	Sum of Squares	Mean Squares	Calculated F value	Needed F value for significance
Total	27	245			
Treatments	6	211	35.2	21.7	2.55 (5% level)
Error	21	34	1.62	3.76	(1% level)

Least difference necessary for significance: 7.6 at 5% level, 10.2 at 1% level.

TABLE 2—SHOWING THE STIMULATING EFFECT OF CERTAIN CHEMICALS ON THE DEVELOPMENT OF STEM-END ROT.\*

Treatment	% of SER* after 3 wks.
Check	48
Copper sulphate 0.1%	56
Sodium hypochlorite 0.05%	78

From many tests during the past year the least difference necessary for significance at the 5% level of probability between lots of 100 fruit each in the amount of stem-end rot that developed in 3 weeks of storage has ranged from 5.8% to 15% with an average of 8.1%. From these observations it is apparent that if the experiments are not set up in such a way as to lend themselves to statistical analysis one must look for a difference of at least 12 to 15% between the percentages of stem-end rot which develops in three weeks among treatments applied to lots of 100 fruit each and randomized between themselves before that difference can be considered. If no randomization is possible even greater differences must be obtained before they can be definitely assumed to be significant.

When it was found possible to interpret results from individual experiments, many tests were made to try to answer such questions as what, when and how certain chemicals might be applied to the fruit, or what mechanical means might be used to reduce decay. It has been pointed out by Hopkins and Loucks (3) that the packinghouse process as exemplified by tests from 6 different packinghouses did not affect the amount of decay that developed during three weeks in storage. Hopkins and Loucks (5) showed that picking of the fruit by pulling did not increase the amount of decay over that produced by clipping. It was found that the removal of the buttons after they had been loosened by treating the fruit with ethylene gas, removal of the calyx when pulling the fruit from the tree, or debutting by certain mechanical means decreased the amount of stem-end rot (4).

One of the paradoxes of these investigations

is the fact that certain known fungicides actually increase the development of stem-end rot instead of reducing it. A typical result of soaking freshly picked fruit in solutions of  $\text{CuSO}_4$  or  $\text{NaOCl}$  is shown by the average of two experiments in Table 2.

Other chemicals which increased the development of stem-end rot are sodium thiosulphate 1% or 5%, ethylene gas 1/10,000 for 48 hours, and acetylene gas 1/10,000 for 48 to 72 hours.

A combination of copper sulphate and sodium thiosulphate increased the amount of stem-end rot in fruit obtained from two different locations even though the amount of copper used was very small. In Table 3 is shown the rot-stimulating effect of copper sulphate and sodium thiosulphate.

In order to test the antagonistic value of thiourea against the increase of stem-end rot by a mixture of 0.1% copper sulphate and 1.0% sodium thiosulphate a test was made using this mixture as a dip for 6 hours followed by a 5-minute dip in a 5% thiourea solution which was allowed to dry on without rinsing. The data in Table 4 show that the copper mixture greatly increased the amount of stem-

TABLE 3—THE STIMULATING EFFECT OF COPPER SULPHATE AND SODIUM THIOSULPHATE ON STEM-END ROT OF FRUIT FROM 2 DIFFERENT LOCATIONS

Solution	% SER after 3 weeks. Fruit from location.	
	1	2
0.1% $\text{CuSO}_4$ $5\text{H}_2\text{O} + 1.0\% \text{Na}_2\text{S}_2\text{O}_3$	72	54
0.05% $\text{CuSO}_4$ , $5\text{H}_2\text{O} + 1.0\% \text{Na}_2\text{S}_2\text{O}_3$	64	42
Check, No treatment	14	10

end rot over that in the untreated check, 74% against 32% at 3 weeks. The combination of the copper mixture followed by thiourea pre-

vented the development of any stem-end rot.

The results from certain experiments indicate that some of the natural products of metabolism of stored citrus fruits increased the amount of stem-end rot. Since it is known that ethylene gas increases stem-end rot and ethylene is one of the products of metabolism, an experiment was set up to determine if the removal of this or some other gas would be effective in reducing the rots.

TABLE 4—SHOWING THE ANTAGONISTIC EFFECT OF THIOUREA AGAINST COPPER FOR INCREASING THE DEVELOPMENT OF STEM-END ROT.

Treatment	Amt. of SER after			
	1 wk.	2 wks.	3 wks.	4 wks.
Check	0	18	32	36
0.5% $\text{CuSO}_4$ -				
1.0% $\text{Na}_2\text{S}_2\text{O}_3$	34	68	74	80
Same followed by				
5% thiourea	0	0	0	0

One lot of fruit was sealed in a 50-gallon drum, another was placed in a drum in which the air was circulated over potassium permanganate and potassium hydroxide to absorb the ethylene, carbon dioxide and perhaps other gases. A third lot of fruit was held in ordinary

TABLE 5—EFFECT OF REMOVING METABOLIC PRODUCTS

Treatment	% SER after 3 weeks
Closed drum	54
Closed drum + $\text{KMnO}_4$ + $\text{KOH}$	10
Check ordinary storage	12

storage. The results are shown in Table 5 which indicates that the removal of metabolic products is important in controlling stem-end rot.

Various methods of storing fruit that would naturally allow varying accumulations of

ethylene or other metabolic products were tested and Table 6 shows that the type of storage providing the most ventilation and which most effectively removed these products is the best from a control standpoint. In this connection it should be mentioned that by immediately sealing the stem of clipped fruit by paraffin, which would retard or prevent the exchange of gases through the stem tissues, the development of stem-end rot was greatly increased.

Another experiment was set up to test the suggestion that fruit picked by clipping with dull clippers developed more rot than fruit which is picked by cutting the stem with a very sharp knife. The results showed that the fruit picked by cutting developed enough less stem-end rot than those picked by the dull

TABLE 6—RESULTS OBTAINED BY VARYING THE DEGREE OF VENTILATION IN STORAGE SPACE

Type of Storage	% SER after three weeks
Sealed in drum	80
Drum covered with cheese-cloth	54
Commercial storage, with air circulated	36
Ventilated drum	36
On trays in large open room	24

clippers to be just on the borderline of significance. The stem tissue crushed by the clippers may have formed more of a blockage to the free passing of gases through the stem end than did the tissue which was cut by the sharp knife and not crushed.

Activated carbon which was saturated with bromine was very effective in controlling stem-end rot when placed in cloth pads and enclosed in packed boxes of oranges. Under the circumstances of the tests, the molds were slightly increased, but it is believed that by more refined methods this harmful effect could be eliminated. The results from one experiment are shown in Table 7 where stem-end rot was

reduced by activated carbon saturated with either bromine or chlorine.

TABLE 7—DECREASE IN STEM-END ROT CAUSED BY ACTIVATED CARBON FORTIFIED WITH BROMINE OR CHLORINE

Treatment	% SER during 2 wks. storage
Check	10
Activated carbon	17
Activated carbon + bromine	0.8
Activated carbon + chlorine	6

Results from the above mentioned experiments uphold the theory that something in the metabolic process hastens the development of stem-end rot and that anything which reduces the accumulation of metabolic products, possibly ethylene, will retard the development of rots. In this connection, since the movement of oxygen into and from the stem tissue was modified by all of these tests, the possibility of these results being associated with an oxidation-reduction interaction was considered. However, oranges treated with various oxidizing agents developed as much rot as untreated. Attempts at toning the rind physiologically to make the fruit more resistant to rots by the use of various ions such as Ca, H, Fe, Mn, Al, and Zn were unsuccessful.

It has been known for a long time that if the buttons can be removed from the citrus fruits their predilection to stem-end rot was greatly reduced. Because the removal of buttons involves a great amount of labor, methods were tested that might loosen the buttons enough that they would be rubbed off by the regular packinghouse machinery brushes. Fruits were soaked with various hormones and other chemicals to no avail. Gassing with various materials seemed to give some promise, so a tensiometer was used to record the relative tension necessary to pull the buttons from oranges after they had been treated with various gases. It was found that these gases

were effective in causing the buttons to loosen in the following order; ethylene the most effective and ether the least; ethylene 1:5000, acetylene 1:5000, chloroform 1:100; benzene 1:123, carbon tetrachloride 1:138, toluene 1:150 and ether 1:146. Approximately six times as much pull was required to remove the buttons from fruit treated with ether as from those treated with ethylene. So long as the fruit is picked by pulling as it is at present, no means of removing the buttons by the brushes will be possible. In fact, a sufficient number of buttons clipped with short stems and gassed with ethylene were not removed by the brushes to give a commercial control of stem-end rot. It would be necessary to cut the stems longer than is best from the stem-puncture injury standpoint. Until some means is devised for economical removal of the buttons this method of control appears to be ruled out.

Approximately 75 chemicals were tested for their fungicidal action against the four organisms involved in this discussion by incorporating them in agar plates inoculated with the

fungi. Among them the following were found to be effective in controlling one or more of the organisms in culture: 8-hydroxyquinoline, chlorothymol, thymol, copper sulphate, allyl isothiocyanate, cupferron, and 8-hydroxyquinoline sulphate when used at concentrations of 500 p.p.m. Thiourea was effective at a concentration of 3%. When these chemicals were used as a dip or in conjunction with wax, thiourea was the only one which was effective in controlling the fruit rots. As mentioned before, copper sulphate actually increased the amount of rot.

The above results indicate that culture tests to determine the effectiveness of chemicals in controlling rots on citrus fruits are not practical. It was discovered that a drop of a chemical in solution placed on the buttons of the fruit is a more reliable means of quickly and cheaply testing the efficacy of the chemical (6). Approximately 50 chemicals have been so tested and the following have given good results: merthiolate, thiourea, 8-hydroxyquinoline sulphate, 2, 4, diamino-diphenylamine, 8-

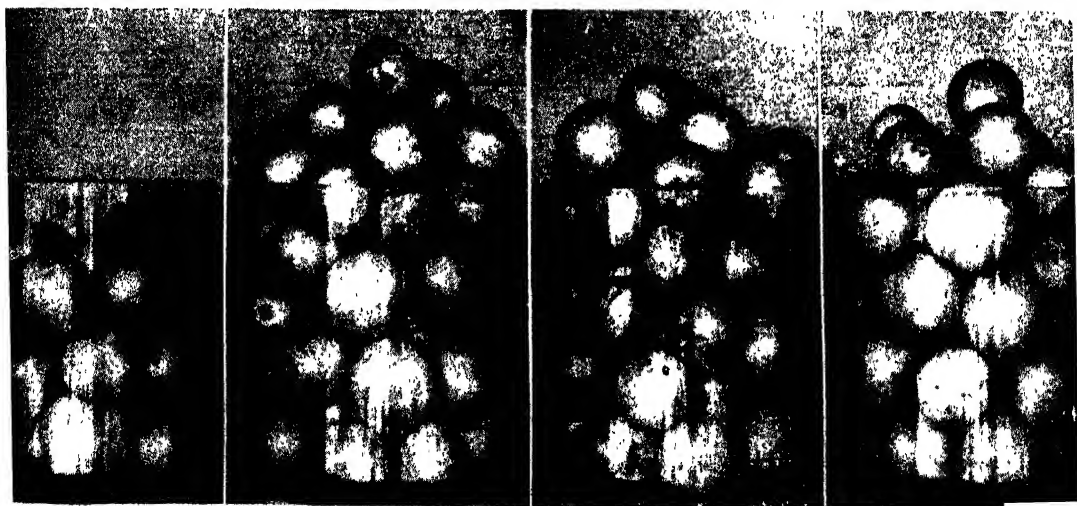


Figure 1. Reduction of decay obtained by painting the buttons with various chemicals. Sound fruit remaining after 5 weeks in storage. Left to right: Check (no treatment), merthiolate, 8-hydroxyquinoline sulfate, thiourea.

hydroxyquinoline base in oil, 2 methyl-1, 4-naphthoquinone, naphthol, phenyl-mercuric acetate, phenyl-mercuri-trichloroethanol ammonium lactate, and thiosemicarbazide. In Figure 1 is shown the amount of sound fruit remaining after 5 weeks, when comparing those having buttons painted with certain chemicals against those that were not painted.

Not all of these compounds have been further tested to discover their effectiveness when applied in some manner which is commercially possible. Many of the 8-hydroxyquinoline derivatives have been tried but con-

sistently good results have not been obtained by any method used so far. It has been used mostly in the sulphate form because it is more soluble. Thiourea has been tested very extensively and has been found to control the rots effectively when the fruit was subjected to a 10% solution for 6 to 10 minutes. An increase in temperature of the treating bath to 55°C improved the efficiency of the treatment as did also a hot treatment in a 25% solution for 2 minutes or a 30-second submersion in a 10% solution at room temperature and the fruit allowed to stand for 1 hour before the thiourea was washed off. The use of thiourea

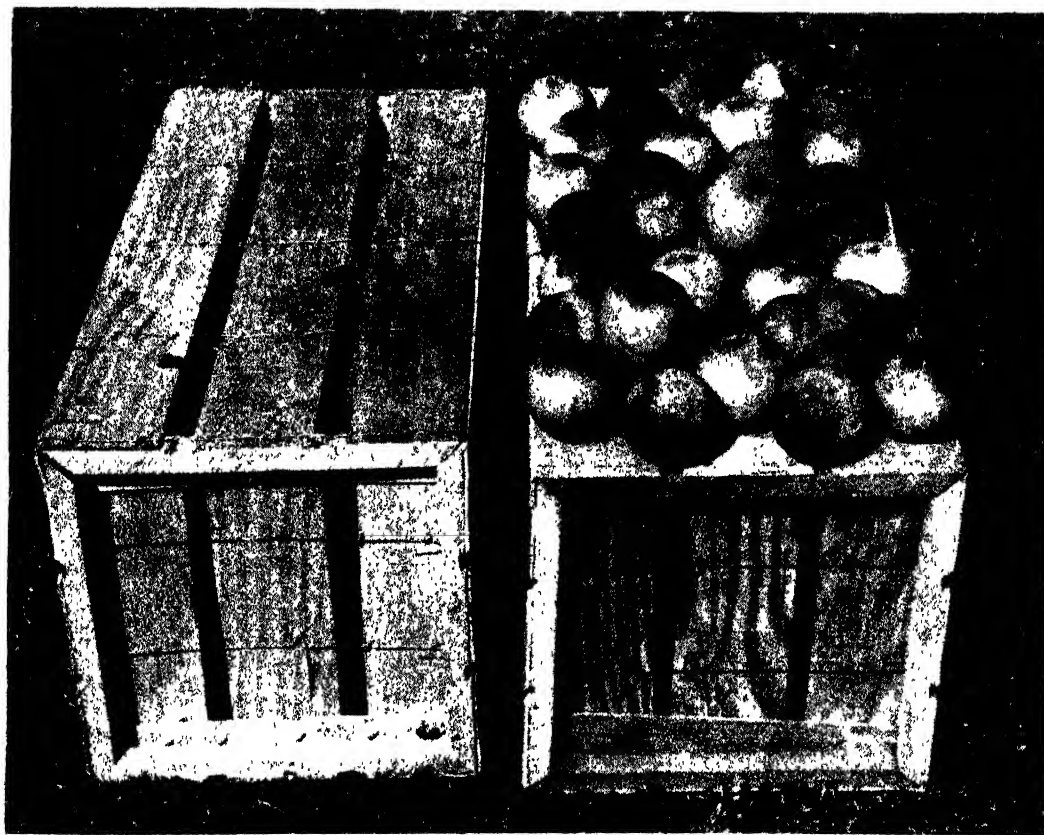


Figure 2. Effect of 10% thiourea in soaking, scrubbing, and color-add sections of the packing-house process. Amount of decay during 2 weeks in storage from treated box is shown on the left and from untreated regular packed box on the right



is prohibited at the present time because its toxic effect on humans is not yet known.

A few proprietary materials that have been supplied by their distributors have been given very thorough tests for their ability to control rots. Paper mats containing some ammonium compound were found to give no control over stem-end rot or molds when 8 to 24 wafers were placed in a packed box of oranges. Various green paper wraps were extensively tested on oranges and grapefruit for their ability to control storage diseases in lighted and darkened storage rooms. They were found to have no effect on the diseases and shrinkage was just as great in the green wraps as it was in the light orange colored paper wraps that are commonly used for wrapping citrus.

Two epoxides, ethylene oxide and propylene oxide, which were tried as fumigants proved ineffective at any concentration that was low enough to be harmless to the fruit rind.

Although at the present time no usable chemical has been found that is highly effective against citrus storage rots by any of the methods so far used, that is cheap enough to be profitable, and whose toxicity to humans

is known, the results reported here seem very hopeful that such a compound can be discovered.

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## PROBLEMS IN THE DEHYDRATION OF ORANGE JUICE<sup>1</sup>

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A process has been developed employing vacuum diffusion for the dehydration of orange juice to a virtually anhydrous powder. The powder is extremely palatable and should go far in increasing the distribution of orange juice to segments of the world's population

now deprived of this valuable food. The dehydration can be stopped short of the powder state to make a concentrate which can be sold as a frozen food. This frozen concentrate when reconstituted with three times its volume of water closely approximates fresh juice.

The purpose of the present paper is to discuss the process and describe some of the problems involved, as well as to present data in the hope that some duplication of effort by other workers may be avoided.

Orange juice is screened and circulated at a temperature of 55°F. through concentrators where the water is evaporated under vacuum until the concentration reaches 50 to 60%

<sup>1</sup>Presented before the American Society of Horticultural Science meeting, St. Louis, March 1946.

solids. At this point some of the concentrate is further dried to powder, some is stored at 0° F. and the remainder is blended with fresh juice to approximately 42% solids. This latter operation restores volatiles lost by vacuum concentration. The addition of fresh juice to obtain optimum quality was developed by Dr. L. G. MacDowell of the Florida Citrus Commission. A public service patent for this procedure has been requested by the Commission.

The concentrate is introduced into large vacuum driers where it is dried to a powder containing not more than 1.5% moisture at temperatures in the order of magnitude of room temperature. Pressures obtained in this step go as low as a few microns, with 100 microns typical of the end of the cycle.

In the drying of the concentrate to powder, the driving force for movement of water vapor in the vacuum is a trap in series with the pumping line. This is held below -50° F. and its surface is continually renewed by rotating scraping blades. In this way maximum effectiveness is obtained from the refrigeration, since ice, which is a heat insulator, is never allowed to accumulate on the condensing surface.

The powder and concentrate are readily rehydrated to a drink containing 11.3% solids. This serves to introduce the horticultural aspects of the problem. The processor buys juice having from 9 to 15% solids but sells on a fixed solids basis. Orange varieties having high solids content and capable of high yields would be of great interest. Perhaps the time will come when oranges are sold on a solids basis. This would certainly encourage further genetic research.

Extremely thorough work by Paul L. Harding (3, 4) and coworkers on seasonal changes in Florida oranges forms a basis for planning operational schedules of a dehydrating plant. It gives data on solids, acid, ascorbic acid, pH, and ratio of total soluble solids to acidity as a function of time and rootstock. The work is a guide to intelligent blending of orange juice which should go far in making for uniformity in taste and in maintenance of a relatively high level of ascorbic acid. Stahl

(9) has made blends of orange concentrate containing, for example, 25% Valencia and 75% Parson Brown or Hamlin juice. The taste is superior to the Parson Brown or Hamlin alone and, therefore, these early season juices of very high ascorbic acid content, which are rather thin in taste, can be advantageously used with late Valencia, which is full-bodied but rather low in ascorbic acid. Harding's taste studies show that a ratio of total soluble solids to anhydrous citric acid of at least 10 or 10.5 to 1 is necessary in order to have maximum palatability. Here again is a useful tool in intelligent blending and scheduling.

Concentrate made in this laboratory of a mixture of Hamlin and Parson Brown juice was of higher palatability than the initial juice, probably because it was reconstituted to 12% soluble solids as compared to an initial value of 9.5%. It had more "body."

Studies will have to be made over several seasons before precise recommendations on blending can be made, however.

Orange juice is recognized as a rich carrier of vitamin C. Table 1 summarizes changes in ascorbic acid in production of orange concentrate having 50 to 60% solids. The mean retention was 96.6%. Data for six dehydrations of juice to powder gave the following recoveries in percentage, 97.3, 98.8, 92.3, 95.4, 96.6, 99.0. The mean retention was also 96.6%. It should be emphasized that these are pilot plant data representing in some cases purposely drastic treatments for experimental reasons. The temperatures employed were often greatly in excess of, and the times of treatment as much as several hundred percent higher than, the current technique used in the pilot plant and the procedure used in the newly constructed production unit, Vacuum Foods Inc., formerly Florida Foods, Inc. Two values of 102% recovery were obtained. It is felt that they arise from sampling error.

The stability of flavor and ascorbic acid in any processed orange juice product is of tremendous significance. The vitamin C level when the purchaser consumes canned, concentrated or powdered juice is important from

the human nutrition viewpoint. Moore, Wiederhold and Atkins (7) report for canned orange juice retentions of 81.7 and 95.1% of the initial ascorbic acid after six months storage at 80°F. and 40°F. respectively. The method of analysis used was the standard indophenol procedure. (2) Four batches of

Dowell and Heid (6) in a review of proposed methods of making powder and concentrate quote Stevens (11) as saying that orange juice concentrate stored at -5° F. for six years retained over 90 percent of its ascorbic acid. Tests in this laboratory (Plymouth) for shorter periods confirm the above finding.

TABLE 1—CHANGES IN ASCORBIC ACID MANUFACTURE OF ORANGE CONCENTRATE HAVING 50% SOLIDS

Run No.	Ascorbic Acid mg/gm dry basis		Percentage Recovery
	Fresh juice	Concentrate	
A1	4.11	3.94	95.8
A2	4.53	4.38	96.6
A4	5.02	4.74	94.5
A6	4.84	4.70	98.4
A7	4.75	4.72	99.4
A8	4.29	4.22	98.4
A9	4.48	4.29	95.8
A10	4.37	4.05	94.8
A11	4.39	4.13	94.1
A12	4.26	3.86	90.6
A14	3.91	4.01	102.0
A15	4.12	4.10	99.3
A16	4.65	4.65	100.0
A17	4.12	4.03	97.8
A18	4.25	4.11	96.7
A19	4.23	4.19	99.1
A21	3.99	3.77	94.5
A22	4.33	4.14	95.7
A23	3.99	3.92	98.2
A24	4.18	3.64	87.0
A25	4.16	4.07	97.8
A26	4.24	3.96	93.4
A27	3.71	3.79	102.0

Mean percentage retention of ascorbic acid in concentrate 96.6%

orange powder made by the vacuum diffusion process were stored six months at about 80°F. The average retention of ascorbic acid was 99.2%. The powders were loose and fluffy, rehydrated easily, and had a good taste when opened. Moore, Atkins, Wiederhold, Mac-

Where a great many determinations of ascorbic acid are being made a rapid method of analysis is highly desirable. Stevens (10) has shown that for citrus juices iodate titration values closely check indophenol titrations. Ballentine (1) has also reported this and gives a

slightly simpler technic. Table 2 gives a comparison of values obtained in this laboratory by the Ballentine procedure and by the widely used indophenol titration.

in orange powder is good. Of course, a product containing high amounts of fructose does not retain excellent flavor at 100° F. for many weeks, especially if amino acids are also pres-

TABLE 2—ASCORBIC ACID IN MG/GM

Sample	Indophenol Titration	Iodate Titration	Photometric Analysis
Fresh juice	0.469	0.472	
	0.471	0.474	
	0.471	0.474	
	Average 0.470	0.473	
	2.04	2.09	
Orange Concentrate	2.06	2.05	
	2.04	2.05	
	Average 2.03	2.06	
	3.89	3.96	
Orange Powder	3.94	3.96	
	3.92	3.94	
	Average 3.92	3.95	
Orange powder No. 14 stored several months at 100° F.	2.59*	2.69	2.59*
Orange powder No. 33 heated to 100° F. for a week	2.70*	2.87	2.67*

\*Data obtained by Bernard L. Oser, Food Research Laboratories, Long Island City, N. Y.

It will be seen that the iodate values for the first three samples are approximately 1% higher than the values obtained with indophenol. In order to determine whether powder that had been subjected to very severe ageing tests gave a fictitiously high value, careful analyses of two samples of powder were made by the elaborate method of Hochberg, Melnick and Oser (5), which minimizes errors caused by reducing substances other than ascorbic acid. Powder stored at 100° F. for a week or for several months had ascorbic acid levels 6 and 4%, higher respectively by the iodate method than by indophenol titration. The photometric method, which includes dehydroascorbic acid, gave analyses within 1% of the indophenol titration values.

At room temperature the retention of flavor

ent. The use of 100° F. constitutes, therefore, an accelerated ageing test. The flavor retention in the powder at 75° to 85° F. is so good, however, that it constitutes one economic argument for its production in spite of costs higher than canned juice. The results of hundreds of taste tests of new and aged powder are almost universally expressed as "excellent, not quite so good as fresh juice but far superior to canned juice."

It may be of interest to list here several of the technics employed in this laboratory in stability and drying rate studies. Water content changes are important in both the above. Since some reactions involving sugars are accompanied by decrease in water (hydrolysis of disaccharides) while others release water (amino acid-sugar reactions and degradation of monosaccharides) one can obtain clues as to reactions involved by accurate measurement of changes in water content. Moisture deter-

minations dependent upon complete removal of water by vacuum drying were found to be inadequate because of (1) excessive time required to reach constant weight and (2) breakdown of the material at the high temperature needed, 60° C. The measurement of the equilibrium vapor pressure over powder as an index of water content was studied. The pressures are correlated with the amount of water but the manipulations are very delicate and the time to reach equilibrium was often as long as an hour. The Fischer method (12) was found to give highly reproducible results after either storing a sample overnight in anhydrous methanol or heating it 20 minutes at 55° C. A simplified titrimer for this analysis designed by Glenn Mellen of this company was made at cost of less than five dollars and was completely satisfactory. This is less than 10% of the cost of a commercial titrimer, primarily because only current measurement is involved instead of potentiometric. Briefly, it consists of a Triplet 0-200 microampere meter, a 1.5 volt flashlight battery and resistors which impress a potential of 15 millivolts across two platinum electrodes in the analytical solution. When the titration is complete the current drops from 75 to 100 microamperes to zero.

Total and reducing sugars are analyzed by a modification of Scales technic (8). Data on water and sugar changes will be reported elsewhere. Preliminary data from five storage runs show that samples having 1.1% water or less initially experience increases of approximately 30% after three weeks at 100° F. These are followed by very slight changes up to nine weeks. Samples held at 80° F. show slight but definite increments, 3 to 15 per cent, after three weeks, beyond which time the changes are very much less. After 25 weeks at 80° F. the water content was within 10% of the value obtained at 3 weeks. Preliminary data on changes in total and reducing sugars have shown no notable changes. Titratable acidity and pH are usually followed in storage studies but as yet no significant changes have been observed.

A great number of experiments have been

run on a small laboratory scale instead of in the pilot plant. Two useful tools were at hand for drying an experimental concentrate and its control to a powder. One is a cabinet dryer made in the shop, consisting of a vacuum-tight square box, 24 inches by 16 inches by 10 inches. It has a self-contained pumping system capable of holding 20 microns pressure, a heating system controlled by a variable transformer, thermocouple selector switch for reading temperatures at various places inside the cabinet, a dry ice-acetone water vapor trap and a "thermocouple gauge" panel by which pressures are read directly in microns on a dial. The gauge consists of a filament with an attached thermocouple. The heat input to the filament is kept constant. Variations in pressure cause variations in the temperature of the thermocouple, the current from which is read on a scale calibrated in microns pressure. The gauge employs the principle that removal of heat from a filament varies with the concentration of vapor molecules surrounding it. A McLeod gauge was used at times but the particular gauge employed is not accurate in the presence of water vapor above pressures of 100 microns. When total pressures were desired the thermocouple gauge could be calibrated for water vapor or the Alphatron gauge was used. This gauge reads directly in pressure from one micron to 10 millimeters of mercury and from a graph up to one atmosphere. It has a radium source of alpha particles and the ionization current reaching a grid is directly proportional to the molecules of vapor present since the emission of alpha particles is constant.

A second device was made which while of small capacity, was found to be decidedly valuable. It consists of two pyrex desiccators with standard taper female fittings at the top (also called vacuum distilling apparatus—Central Scientific catalog No. 12910). Into each was fitted a manifold, one end of which was tapered to 1/4 inch and was sealed by pressure tubing and clamps. Thermocouples could be introduced through the tubing. The rest of the manifold was 1 1/2 in diameter and led into a common copper pipe at right angles to the manifolds, which in turn was in series with a

dry ice trap and a vacuum pump. The two desiccators were thus in parallel and were totally inclosed in a small thermostatically controlled oven. The external temperature could then be adjusted and both vessels reached the same temperature at the same time. Any available pressure reading device could be used. In this small dryer differences in drying rates caused by different treatments of the juice could be observed. Control runs showed that conditions could be closely duplicated so that two separate dehydrations of a concentrate had points on a drying curve that never deviated by more than 0.1% water from each other.

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## CITRUS PRODUCTS TECHNOLOGY

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Food Technology was one of the earliest arts practiced by primitive man. Capturing or finding his foods where and when he could, this hunter and forager was impelled by lean seasons to develop crude methods of preservation by salting, smoking, drying and cool storage, before he learned to cultivate plant and animal crops.

However, the development of Agriculture outstripped that of Food Technology, and it is only within the last ten years that the

applied science of processing and distributing food products achieved the maturity of a national Institute of Food Technologists.

Basic foods may be conveniently classed as grains, fruits, vegetables, spices, nuts, condiments, meats, fish, poultry and dairy products. Methods for processing fruits and vegetables are generally similar and are ordinarily considered together. Within this field, citrus product technologists apply skills in horticulture, plant physiology, microbiology, enzymology, chemistry, physics, engineering, cooking, nutrition and related arts and sciences to the selection, harvesting, processing, packaging and handling of citrus fruits and products and the

utilization and disposal of residues and wastes.

Citrus product technologists find employment in many phases of production, control and research. The purpose of this discussion is to describe a suitable laboratory organization plan and review contributions of technologists to the development of the citrus products industry.

#### LABORATORY ORGANIZATION

The organization of commercial citrus product laboratories should provide for:

*Research:* Many research projects are unique. Others fall into general classes as the investigation of varietal suitability for specific products and processes under local conditions, studies of the improvement of products, the reduction of costs, the development of new products, and nutritional factors affecting the marketing of products.

*Information:* The maintenance of an adequate technical file and library is essential.

*Engineering:* A function of citrus product technologists is to aid in developing and designing new and improved equipment.

*Personnel training:* Laboratory personnel desirably assumes responsibility for instructing and training technicians and plant test-station operators.

*Checking:* A related responsibility is the checking of operators, instruments, processes, supplies, raw materials and finished products.

*Advisory Service:* A major function of citrus products technologists is to furnish advisory service to business, production, advertising and sales management. This service may relate to such widely varied phases of the operation, as: The selection of varieties; harvesting and handling of raw materials; processing, packaging, storing and transporting products; plant sanitation; utilization and disposal of wastes; technical phases of contracts, patents, advertising and sales promotion; trouble shooting; customer service; handling of complaints, nutritional properties and the cooking, serving and acceptance of products.

#### COMMERCIAL DEVELOPMENTS

*General:* In Mediterranean countries lemon oil and citric acid were among the first citrus products prepared commercially (5). In the United States, marmalades, canned grapefruit segments and orange beverage bases were pioneering developments (3, 9). Carbonated beverages containing no fruit juice had been manufactured from sugar, acid, carbonated water, artificial color and flavors. Beverages made with orange bases contained concentrated orange juice equivalent to about five percent of juice which resulted in a corresponding improvement in quality. Pulp, lime, lemon and grapefruit juices were also used in this country and were exported for preparing rickeys and squashes. Later, imitation orange-ade, containing less than twenty percent of juice were prepared from bases containing added acid and artificial color together with concentrated juice.

In other early developments, citrus product technologists improved methods for recovering citric acid, essential oils and pectin from oranges and lemons (25, 27, 30, 32, 33). These products were of a higher purity than had previously been available. Costs were reduced, extending the use of these products in the food and pharmaceutical industries.

*Juice Canning:* Technologists in State and Federal laboratories demonstrated methods for flash-heating citrus juices in high velocity heat exchangers (6, 14, 15, 17, 18, 20, 21, 31). However, kettle heating first came into general commercial use. Juice was permitted to come in contact with pumps, valves and tubing made from copper alloys (4, 8, 28). Resulting canned juices were of inferior flavor and keeping quality.

It was not until copper alloys were removed from contact with the juice and stainless steel, aluminum and block tin were substituted, that the way was paved for further improvements in canned juice (22, 23).

High-velocity, turbulent-flow pasteurizers have come into general use for heating citrus juice sufficiently to kill instantly yeasts and

spores, and to inactivate enzymes, without local overheating and scorching. Tubes of small diameter, flattened tubes, concentric tubes, partially plugged tubes, and plate-type heat exchangers are used to reduce the thickness of layers of juice through which heat must be transferred and avoid local overheating by providing a high degree of agitation. Maximum juice temperatures ranging from 205° to 240° F. are possible with less modification in flavor than occurred during kettle heating at 170° F.

Heated juice may be cooled rapidly for filling in cans by flash evaporation (in conjunction with de-oiling) or in a heat exchanger containing incoming juice or cooling water. Filling temperatures should be maintained above 170° F. unless facilities are available for sterile-filling, or the filled cans are given an additional heating.

*De-oiling and Deaerating:* The introduction of mechanical juice extractors permitted large scale packing of quality citrus juice products and brought new problems to the industry. One was the control of the quantity of essential oil incorporated from the peel. Citrus peel oil contains a large percentage of terpenes which tend to develop a rank flavor in canned juice held under ordinary storage conditions.

It was found that by heating fruit in steam, hot water or a flame, the quantity of oil in juice could be reduced (29). However, continuous commercial de-oiling deaerators were developed and are coming into general use. In this equipment juice is flash-concentrated and deaerated continuously by passing it through a high velocity tubular heater into a flash chamber maintained under a vacuum. This method represents a modification of the analytical method used for determining the oil content of citrus juices and was tested upon tangerine juice in 1942 by Atkins and associates (1). Its success is based upon the fact that the least stable constituents of peel oil are also the most volatile. It is possible to remove three-fourths of the volatile oil from citrus juice by flashing it through a concentrator, returning condensed volatiles to the juice, while separating the water-insoluble terpene fraction. This process may be applied

in two modifications. In the first, the juice is flashed through the de-oiler prior to pasteurization, emerging from the de-oiler at a temperature ranging from 120° to 140° F., and passing to a heat exchanger for pasteurization. In the alternate procedure, the juice may first be heated to 240° F. before flashing it through the de-oiling deaerator to a temperature of 185° for filling. Atkins and Moore report that the latter method possesses advantages for tangerine juice. (Personal communication).

*Can Filling:* The quantity of oxygen in the head space of canned citrus juices has an important influence upon storage properties, particularly at unfavorably high storage temperatures. Reduction of oxygen in the head space by complete filling, by vacuum closing or by introducing steam or inert gas as can lids are applied, contributes measurably to retarding undesirable flavor changes during warm storage.

*Tangerine Juice:* Tangerine juice is difficult to extract in conventional juice extractors. Under unfavorable storage conditions the canned juice is subject to rapid deterioration. Reasons for the instability of canned tangerine juice are partially understood, and several methods are known for retarding flavor changes. This juice contains enzymes which cause rapid changes unless the juice is handled rapidly after extraction. It contains unstable volatile constituents which can be substantially removed by a flash boiling under vacuum. It contains less ascorbic acid and more easily oxidizable compounds than other citrus juices. For this reason, oxygen in cans should be minimized, and antioxidants may be added to protect oxidizable constituents. Compounds which have been used include ethyl caffeate, sulfureous acid, iso-thymol and ascorbic acid, and related compounds. Skill is required for the proper use of antioxidants.

A reasonably satisfactory pack of tangerine juice can be prepared by extracting in equipment which avoids excessive grinding of the peel, by handling the juice rapidly, adding an antioxidant, heating to 240° F., flashing into a vacuum chamber and cooling by evaporation to 180° F., filling under conditions which ex-



clude air, cooling rapidly and storing the canned juice at temperatures below 70° F., or better below 50° F.

Blending tangerine juice with juice of other oranges or citrus fruits also permits the packing of acceptable products.

*Cooling and Storage of Canned Juice:* After closing, cans of heated citrus juice are cooled rapidly to minimize flavor changes. In conventionally designed coolers the cans are spun under sprays of water as they are conveyed through the cooler. Water may or may not be recirculated through a cooling tower. The cooler is usually designed for multistage operation, the coldest water spraying on the partly cooled cans, and passing successively to warmer stages counterflow to the cans of juice.

Whereas temperatures as high as 115° F. were at one time considered satisfactory for labelling and casing, the desirability of cooling canned juice to lower temperatures to protect flavor is now generally recognized. Cooling to temperatures less than 100° F. is the rule. Methods are being developed to permit cooling cans below 80° F. before labelling and casing. This necessitates drying cans at high speed. Methods being used or tested for drying cans include the use of centrifugal force, wiping with heat-dried pads or towels, directing blasts of air against the cans, or passing them through a blast of flame, superheated steam or hot air. If cans are cooled to temperatures lower than prevailing wet bulb temperatures, labelling and casing rooms must be air conditioned, which imposes a practical limitation upon operations.

Storage temperatures of canned citrus juices affect the rate of deterioration in flavor and food value. Warehouse temperatures should never exceed 80° F. During summer months in warm climates, insulated warehouses may be closed in day time and ventilated by exhaust fans during the cool hours of the night, making it possible to maintain temperatures which do not ordinarily exceed 70° F.

Juice canned by best known methods and stored at temperatures below 40° F. shows little deterioration during twelve months. Refrigerated storage is finding some application

in the industry. However, damage may be done to juice *after* leaving warehouses if stored for considerable periods at temperatures in excess of 85° F.

*Sanitation:* A major improvement in citrus juice canning has been in sanitation. Polished stainless steel equipment is designed and installed for close-controlled, straight-line production and easy cleaning. Glazed ceramic tile floors and walls, and glass block walls in juice extraction, processing and filling rooms, offer maximum resistance to attack by acid juices and cleaning agents. Forced ventilation with washed or filtered air, plus frequent and adequate clean-up of extractors and conveyors, plus careful sorting and cleaning of fruit, make it possible to reduce micro-organism counts and insect contamination of products to a negligible minimum.

Inspection by State and Federal agencies is forcing protective measures into most plants.

*Utilization of Peel:* Heid (10) described methods for utilizing the peel in manufacturing dried citrus pulp and citrus final syrup. The complete utilization of the peel in making pectin, alcohol, oil (26), feed yeast, dried pulp and final syrup is possible without creating odor or other nuisances. A bland syrup may be prepared from juice pressed from limed peel. In manufacturing this product the juice is heat-sterilized and filtered, after which it is passed through ion exchangers, concentrated to 40 to 50° F. Brix and treated with activated carbon before final concentration. The resulting syrup compares favorably with refined corn syrup in appearance and taste, but manufacturing costs are higher.

*Dehydrated Orange Juice:* Spray-dried mixtures of lemon juice and corn syrup, containing a high percentage of non-juice solids, has found a market for baking and other uses. Citrus product technologists have sought a method for dehydrating orange juice by which means a reasonably stable product could be distributed and reconstituted to the initial concentration to form an acceptable reconstituted orange juice. To accomplish this objective, it was necessary to develop methods which could be operated substantially without additives and

to reduce the moisture content sufficiently to avoid deterioration of the powder during storage.

In 1842, Heid and Atkins investigated the drying of concentrated orange juice under vacuum and developed a method for preparing a granular material without any added spreader. Protected from moisture and oxygen, this product could be reconstituted to yield juice as palatable as that reconstituted from the concentrated juice from which it was prepared. The addition of small quantities of lactose to the initial juice made the dried product somewhat easier to handle without materially altering the taste. The method was adaptable for application in a vacuum drum dryer without a booster jet, using unrefrigerated water for condensing vapors. A public service patent application was prepared and forwarded to the Chief of the Bureau in which the work was done.

At the 1946 meeting of the Institute of Food Technologists, Sluder and associates presented a description of work on a somewhat similar method in which a belt dryer was employed instead of a drum.

The cost of such methods of drying is less than drying by sublimation; however, sublimation-drying of orange juice may yield a product with a food value equal to and a flavor superior to that produced by simpler methods. Several laboratories have worked upon the development of equipment to permit the continuous manufacture of such products at competing cost. Commercial installations are in prospect.

*Concentrated Citrus Juice:* Orange, lemon, grapefruit and tangerine juices have been concentrated at pressures below atmospheric in circulating evaporators (1, 2, 7, 11, 16, 21, 24). The products have found wide application in beverage and sherbet bases and more recently in the preparation of reconstituted juice. When orange juice of suitable quality is concentrated in properly designed and operated equipment, and the resulting product is stored at not to exceed 35° F., the food value of the reconstituted juice approaches that of the original closely, and the slight modification in flavor may be less than occurs in the flavor of raw

whole fruit during distribution to distant consumers.

During the war, concentrated juice of this type was used in England to protect the health of nursing and expectant mothers and children under five. The effect upon death in child birth, and upon infant mortality and health furnished a striking demonstration of the potential value of this material in overcoming a nutritional deficiency of great prevalence (12). Dairies in the United States have undertaken to distribute reconstituted orange juice with milk, and this operation is meeting with success. Reconstituted juice is being served to an increasing extent in hospitals, army messes, drink stands and similar places. The fact that it is prepared from fresh, tree ripened fruit and distributed and stored at low temperatures has been a major factor in assuring quality and expanding markets.

*Frozen Citrus Products:* Orange juice may be preserved with little deterioration in flavor or food value for as long as five years if properly prepared, handled rapidly, quick-frozen in gas-tight containers, and held at uniform temperature not to exceed 0° F. Freezing rapidly and amorphyously, and storing at uniform temperature, minimize flavor and texture changes. Gas-tight containers prevent dehydration and also oxidation by atmospheric oxygen.

The distribution of frozen orange juice has been limited because storage and distribution costs are high and it is difficult to train consumers to defrost the frozen juice in a manner to avoid objectionable deterioration in quality.

In order to overcome these difficulties, citrus product technologists have sought to develop methods for preparing frozen, concentrated citrus juices in which savings in weight and container requirements would tend to offset the cost of frozen storage, and which could be defrosted quickly and easily without flavor changes, the water thawing the frozen concentrate and the frozen concentrate chilling the water so that the reconstituted juice would be ready to serve immediately.

Moore (24) and associates concentrated juice by rapid evaporation under a high vac-

uum at about 50° F. to 60 percent soluble solids and then added sufficient unconcentrated juice to reduce the solids to about 41 percent. When this concentrate was quick frozen in gas-tight containers and held at 0° F., it could be reconstituted into juice which tasters could not distinguish from the original. Equipment has been developed for preparing this product within a few minutes at nominal cost.

Commercial installations are being made for manufacturing and distributing this exceptionally fine frozen concentrate, and pending the availability of products of this type some manufacturers are mixing conventional concentrate with single strength juice and freezing the resulting mixture for distribution.

In the Linde-Krause procedure (19) fruit juices are concentrated continuously by separating frozen water upon a refrigerated drum from the juice flowing through a trough. The method is reported to give good quality two-to-one concentrations of clear fruit juices. Commercial application to citrus juices remain to be developed.

**Fundamental Research:** Technologists of American citrus producing sections have organized a Citrus Products Research Council to foster, stimulate and coordinate fundamental research on citrus fruits and products. A major objective is to secure information which will permit extension of the storage life of canned citrus juices and related products (13). Studies of the carbohydrates, nitrogen compounds and enzyme systems are emphasized. Standards of identity and quality and methods of analysis are also listed for study. State and Federal agencies have undertaken projects in these fields.

Another research project of considerable urgency to the citrus products industry is the study of the composition of the liquid pressed from citrus cannery residue before it is dried. This liquid contains suspended solids and a series of compounds which coagulate when the juice is heated in the process of concentration to form a valuable feed syrup. This coagulation introduces problems of scaling in evaporator tubes and by determining the composition of substances precipitated at various tem-

peratures, most advantageous methods of handling might be established. Knowledge is also needed of the composition of final syrup made from this liquid. Unpublished reports indicate feeding properties different from those of black strap molasses. It may be surmised that some of these advantages may be due to compounds with vitaminic properties, particularly factors influencing capillary fragility and permeability. However, a complete study of the nutritional and other properties of this syrup for use in feeds and in preparing beverage alcohol would be of value.

Refined bland syrup and partially refined syrups can be prepared from this liquid by separating non-sugar solids, and some of these non-sugar solids may have important nutritional properties.

New citrus products in prospect include dessert and salad products incorporating low-methoxy pectin derivatives and concentrated juice products for home use in preparing juice and ades.

**Nutrition Research:** Citrus fruits and products are recognized as the richest and most stable source of ascorbic acid available to and relished by the American public in equivalent quantities (12). Other nutritional properties are attracting increasing interest of investigators. When more is known regarding these factors and methods of estimation have been developed, the evaluation of citrus products will become increasingly accurate.

**SUMMARY:** Citrus products technologists are playing an essential role in the development and stabilization of one of the fastest growing food processing industries.

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# IDENTIFICATION OF HYBRID AND NUCELLAR CITRUS SEEDLINGS BY A MODIFICATION OF THE ROOTSTOCK COLOR TEST

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In most varieties of citrus a large proportion of the seedlings produced are from nucellar embryos. In citrus breeding investigations it is desirable, for economic reasons, to rogue out the nucellar seedlings as soon as they can be distinguished from the true hybrid (zygotic) seedlings, instead of giving them the space and care required to grow them to maturity. In some instances the hybrid seedling can be distinguished from the relatively uniform nucellar seedlings by differences in size, growth habit, leaf shape, or other morphological features. By this method, however, separation is often uncertain, especially if the observer has not acquired a knowledge, in minute detail, of the characteristics of the parent varieties.

This paper reports the results of an attempt to distinguish between hybrid and nucellar seedlings by means of a chemical color test. The rootstock-bark color test of Halma and Haas (1) was adapted to the rapid testing of large numbers of small samples of leaves.

## MATERIALS AND METHOD

Identification tests were made on over 3,800 seedlings, which were grown from seed obtained in 37 crosses. These crosses involved several species of citrus, two interspecific hybrids, and several intergeneric hybrids of citrus and related genera.

The crosses were made and the seedlings grown in connection with the citrus breeding program of the U. S. Subtropical Fruit Field

Station, Orlando, Fla. In the crosses the following citrus varieties were used: Sweet orange varieties (*Citrus sinensis* Osb.) Jaffa, Norris, Navel, Hamlin, Parson Brown and Valencia; Grapefruit varieties (*C. paradisi* Macf.) Marsh, Duncan, Foster, Thompson, Leonardy and Mott; Tangerine variety (*C. reticulata* Blanco) Clementine, Tangelo varieties (*C. reticulata* x *C. paradisi*) Orlando and Minneola, Tangor variety (*C. reticulata* x *C. sinensis*) No. 653; Intergeneric hybrids, Morton citrange (*Poncirus trifoliata* Raf. x *C. sinensis*), and unnamed varieties of citrumelo (*P. trifoliata* x *C. paradisi*). Mott grapefruit and Clementine tangerine may be interspecific hybrids, but their parentage is unknown.

In preliminary work on methods of identifying citrus seedlings all of the chemical tests described by Halma and Haas (1) and a number of others were tried. Of those tried the most satisfactory for the purpose was the Almen reagent color test adapted by Halma and Haas for use on water extracts of dried bark powder. It was found that this test worked equally well on water extracts of dried leaf powder. The use of leaves rather than bark for identification tests of seedlings has several advantages. Leaves provide relatively uniform tissue that is easily sampled, dried and ground; and, of great importance in this work, the removal of a leaf sample is less damaging to the seedling than removal of a bark sample. Since the number of samples that had to be handled was large and many of the seedlings were so small that they bore only 10 or 12 small leaves, the methods used had to be designed for rapid handling of small samples. The modified method as finally used is summarized below:

1. Several leaves (enough to provide a

0.2- to 0.5-gram sample of dry powder) were collected from each seedling of a cross. At the same time leaves of about the same age were taken from the parent varieties. The samples were dried at 40 to 45°C. in a forced draught oven. Browning of the leaves during drying was avoided. The dry samples were ground to pass a 60-mesh screen in a medium-sized Wiley mill.

2. Samples of 0.2 to 0.5 gram (preferably 0.5) of leaf powder were weighed, transferred to small beakers, and extracted overnight in 5 ml. of distilled water per 0.1 gram of sample (sets of 24 seedling samples from a given cross and one or two samples from each parent variety were run together).

3. The extract was filtered through rapid paper, and 2 ml. of filtrate was pipetted into a 3 x 1/2 inch test tube. Each set of tubes containing 24 seedling samples and the pair of parent samples were supported in a metal serological tube rack.

4. To each 2 ml. sample of filtrate in a tube the following solutions were added in the order listed:

- 2 drops of potassium hydroxide (25 gm. per 100 ml. water stock solution diluted; 1 part KOH to 20 parts water).
- 2 drops copper sulfate solution (saturated).
- 2 drops Almen reagent (160 grams mercury dissolved in 100 ml. fuming nitric acid [sp.g. 1.60] and diluted with 320 ml. water).

5. The test tube rack was shaken vigorously to mix the contents of the tubes and placed in a boiling water bath. The tubes were heated until the heavy precipitate that had formed reached full color. The rack was then removed from the bath and shaken vigorously. When the precipitate had settled a visual comparison was made of the color (shade and intensity) of the solutions from the parents and seedlings.

After the leaf samples were collected, three workers could run about 100 samples per day by this procedure.

It was found, as expected that the color of the nucellar seedling solutions matched the

female parent solution, but that in almost all varieties the intensity of color was slightly less in the nucellar seedling solutions than in the female parent solutions. Why this is true is not known. Sometimes slight variations probably resulted from the difficulty of collecting leaves of the same age from the seedlings and the parent trees. Solutions that showed a difference in shade of color or a marked difference in intensity of color from that of the female parent solution were judged to be from hybrid seedlings. The solution from the male parent was useful only as an indication of what might be expected from the hybrid. That is, the colors of solutions from the hybrids were sometimes intermediate between the two parents or occasionally about the same as the male parent, and rarely the intensity of color of the hybrid seedling solution was greater than that of either parent.

#### RESULTS AND DISCUSSION

The results of the seedling tests are shown in Table 1. The seedlings from all of the crosses were examined by a skilled observer and the seedlings of most of the crosses were classified on the basis of morphological characters as hybrid or nucellar. The seedlings of a few crosses in which Clementine was used as the female parent were not classified on the morphological basis because of the uncertainty of judgment in these groups.

In Table 1 the number of seedlings of each cross that were identified as hybrid by the color test and the number identified as hybrid by morphological characters are shown. In addition, the number of seedlings that had trifoliate leaves, and the number of these trifoliate plants that were identified by the color test (column 7) are listed. Since, in the crosses involving parents with trifoliate leaves the trifoliate plants were used as male parents, it is certain that all of the trifoliate progeny are hybrid. The number of trifoliate seedlings identified that were common to both methods (column 7) as compared to the total number tested (column 5) gives some notion of the reliability of the color test. In a comparison

TABLE 1—HYBRID AND NUCELLAR CITRUS SEEDLINGS IDENTIFIED BY COLOR TESTS AND MORPHOLOGICAL CHARACTERS

Cross	No. of seedlings	Hybrids identified by color test	Hybrids identified by		No. of hybrids identified common to both methods	
			Gen. char.	Trifoliate leaves	Gen. char.	Trifol. leaves
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Marsh x citrangelo	24	4	3	5		3
Davis x citrangelo	46	11	8	10		4
Navel x citrangor	19	3	1	2		2
Duncan x citrangelo	39	10	4	5	1	5
Duncan x citrumelo	46	22	5	1	3	1
Foster x citrumelo	216	103	23	32	12	24
Clementine x citrangor	31	31	16	15	16	15
Clementine x Morton	12	12		10		10
Clementine x Mott	253	253	57		57	
Clementine x Hamlin	25	25	2		2	
Clementine x Orlando	327	327	—			
Clementine x Minneola	277	277	—			
Clementine x tangor	359	359	—			
Clementine x Davis	19	19	—			
Orlando x Hamlin	343	38	31		11	
Mott x Hamlin	252	50	64		37	
Mott x Davis	105	72	29		24	
Mott x Foster	36	21	7		6	
Mott x Clementine	48	7	3		1	
Jaffa x Mott	5	2	2		2	
Jaffa x Thompson	32	6	7		2	
Jaffa x Leonardy	150	19	23		6	
Jaffa x citrangor	50	3	6		3	
Jaffa x citrangelo	3	0	0			
Satsuma x citrangelo	11	0	0			
Satsuma x citrangor	11	0	0			
Parson Br. x citrangor	102	42	7		3	
Davis x citrumelo	8	6	4		4	
Orlando x tangor	70	13	9		1	
Marsh x Hamlin	14	4	3		3	
Marsh x citrumelo	45	9	2		2	
Foster x Mott	158	32	12		4	
Foster x Hamlin	42	0	0		—	
Norris x Mott	37	7	10		5	
Thompson x Morton	5	0	0		—	
Minneola x Clementine	580	117	98		69	
Tangor 653 x Valencia	51	3				
Totals	3851	1907	436	80	274	64

of the number of seedlings from the several crosses identified by each method as hybrid, with the number common to both methods of identification (columns 3, 4, 6, and 7), it is apparent that agreement is fairly close, and is considerably better in most cases than would be expected from chance alone.

Even excluding the Clementine seedlings that were not classified by the morphological method, the number of seedlings selected as hybrid by the color test greatly exceeds the number selected by morphological characters.

When the seedlings selected as hybrid by the color test and by general morphological characteristics come into bearing it will be possible to classify them as hybrid or nucellar on the basis of fruit characters. While classification based upon fruit characteristics is also not infallible, it is the best method available, and later should serve as a measure for testing the reliability of the two methods used to classify the young seedlings.

Color tests made upon extracts from the parent varieties involved in these crosses, exhibited a considerable color range, from a dark pink or claret wine in the case of Clementine and tangor, through light bright pink in the sweet orange varieties and in Orlando and Minneola, to pale lavender in some *P. trifoliata* hybrids, to pale pinkish amber in the grapefruit varieties, and to almost colorless in *P. trifoliata*. When the cross was between parents that gave a striking color difference, it could reasonably be expected that nucellar seedlings would give a color reaction similar to that of the female parent, while most hybrids would be intermediate between the parents in color, and either lighter or darker than the female parent, depending on the direction of the cross. In general, results substantiated expectations, but exceptions were not uncommon. A few seedlings of Clementine x tangor were greenish amber instead of pink. One Clementine x Davis seedling gave a lemon yellow solution.

The method outlined here is probably nearly useless as a tool for selecting hybrids from crosses between varieties of the same species and of little use between any parents that have

similar color reactions, for example Marsh x citrumelo. These two varieties both yield from the color test pale pinkish amber solutions that are almost identical. However, several hybrids were detected in this cross because their solution colors were darker than the others.

Crosses involving Clementine as the female parent were bewildering and discouraging during the first season's work. Color reactions from every one varied so that no two were a perfect match, and the conclusion was reached that few if any nucellar seedlings occurred. In the progeny of Clementine x Morton, 10 out of the 12 seedlings bore trifoliate leaves, while in the 31-plant progeny of Clementine x citrangor 15 were trifoliate and 16 were considered hybrid because of other morphological characteristics. Both Morton (a citrange) and citrangor are intergeneric hybrids and therefore heterozygous for the trifoliate leaf character. Therefore when they are back-crossed to the simple-leaved recessive, segregation can be expected to occur and to produce hybrids that do not have trifoliate leaves. Those facts seemed to substantiate the results of the color test. To further check on these conclusions, Clementine was crossed with *P. trifoliata* as male parent to introduce the dominant trifoliate character into every zygotic embryo. Then any simple-leaved plants could with certainty be considered Clementine nucellar seedlings. Several hundred seeds from this cross were planted. Every seedling had trifoliate leaves, and no twin seedlings appeared. Therefore these facts were accepted as evidence that probably no nucellar seedlings are produced when Clementine is used for the female parent. These facts secured a year later helped to substantiate the conclusions reached from the earlier color tests.

The results of color tests on the citrus species and hybrids used as parents in the crosses described here, as well as tests run on a few other citrus species and citrus relatives, suggest that the color test might be of use as an indication of the possible parentage of hybrids of unknown origin. For example, a pale lavender color will indicate that grape-



fruit and *P. trifoliata* were probably involved in a hybrid showing this color, or dark claret wine color would indicate that *C. reticulata* or possibly one of its hybrids was involved in the cross.

Since the number of hybrids identified by the color test, as well as by general morphological characteristics, was small in crosses involving Orlando, Minneola, and Tangor 653 as female parents, the potentiality of hybrid production by these parents was investigated by crossing them with *P. trifoliata* as the male parent. Out of several hundred seedlings from each cross Orlando produced no trifoliolate plants, Minneola two, and Tangor 653 none. Many twin and triplet seedlings were produced by the seeds of these varieties, which further emphasizes the tendency toward the production of nucellar embryos and suppression of the development of zygotic seedlings. On the other hand, Temple orange (judged by the authors to be a tangor from color tests), crossed with *P. trifoliata* as the male parent, produced only one seedling per seed, and all

seedlings were trifoliolate. This indicates that the Temple orange, like Clementine, produces only zygotic seedlings.

#### SUMMARY

The rootstock color test of Halma and Haas was adapted to rapid testing of large numbers of small samples of citrus leaves; and the method was applied in an attempt to distinguish between hybrid and nucellar seedlings. Data are presented on identification tests which were made on over 3,800 seedlings obtained in 37 crosses involving several intergeneric hybrids of citrus and related genera. This color test offers an additional method to aid in the selection of zygotic citrus seedlings in the process of roguing nucellar seedlings. Because of the cost involved these numerous nucellar seedlings cannot be carried on to maturity for more positive identification.

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## IS OUR PRESENT SYSTEM OF FEDERAL PLANT QUARANTINE ENFORCEMENT ADEQUATE?

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Authority to regulate entry of plants and plant products from foreign countries is vested in the Secretary of the United States Department of Agriculture under the provisions of the National Plant Quarantine Act of 1912.

Briefly, and in part, the Act delegates to the Secretary authority to (1) issue permits for the importation of nursery stock, (2) inspect and safeguard nursery stock from countries lacking an official system of plant inspection and certification, and (3) determine and bring under permit and inspection re-

quirements plants and plant products not covered by the definition of nursery stock with respect to which particular past risk is involved.

To the uninformed it might appear that the authority thus delegated to the Secretary is sufficient to enable him to close effectively all avenues for the entry of foreign plant pests. This is not the case. It is mandatory for the Secretary to issue permits to import from countries where official systems of inspection are established, provided each package is accompanied by a certificate issued by the proper official of country of origin to the effect that the material has been inspected and is believed to be free of pests, and provided that the ship-

ment is otherwise in compliance with certain conditions and regulations.

The Secretary does have authority to forbid entry of plants and plant products likely to introduce into the United States any disease or insect new to or not widely distributed in this country. Several prohibitions of this nature are now in effect. It should be noted, however, that this does not extend to all insects and diseases, but only to those new to or not widely disseminated in this country. This is in decided contrast to the policy adopted by state nursery inspectors throughout the United States, who insist that plants sold to their citizens be healthy and free from insects and diseases of *all* kinds.

In order to make effective the provisions of the Act of 1912 as applicable to nursery stock, the Secretary of Agriculture on November 18, 1918, promulgated the nursery stock, plant, and seed quarantine, known as Quarantine 37. For enforcement purposes, plant material likely to be affected was enumerated under several regulations, which, in general, are as follows:

*Regulation 2.* Plant products capable of propagation, but imported for food, medicinal or manufacturing purposes, except those regulated by special quarantines, are admitted into this country without permit.

*Regulation 3.* Bulbs, corms or root-stocks; cuttings, scions and buds of fruit or nuts; rose stocks; nuts; and seed of fruit, forest, ornamental and shade trees, and others, provided they are free of pulp; may be imported under permit and without limitation as to quantity or use, from countries that maintain inspection services. In the case of foreign countries unable to furnish this service, importations may be made under permit and in limited quantities for public service purposes only.

*Regulation 14.* Provision is made herein for import, in limited quantities and under special permit, of plants not otherwise restricted for the purpose of keeping the country supplied with new varieties or necessary propagation stocks.

Acting upon the theory that a reduction in

volume of imported plants would in itself reduce the degree of risk of entry of foreign plant pests, the Secretary placed quantity limits on the importation of certain nursery stock. It was also provided that this material be grown under quarantine until repeated inspections had shown that they were free from injurious insects and diseases, the presence of which it was not possible to detect at time of port of entry inspection.

Several years ago the Solicitor of the Department of Agriculture advised the Secretary that he was without authority to impose either quantity limitations or post-entry quarantine. The authority to "prescribe conditions and regulations" governing the issuance of permits to import, as provided in the Act of 1912, must deal with matters and things bearing on such importations *before* the nursery stock is actually imported, and the law does not seek to control or enforce any regulations on plants *after* their entry, other than those relating to interstate movement. It became necessary, therefore, for the Secretary to rescind all requirements as to quantity limits and post-entry restrictions.

As a result, the country has for several years been wide open to a flood of imported plants, together with such insects and diseases as may be present, from countries that maintain an official system of inspection. Officials of the Department may dispute this statement and claim that such arrivals are inspected and, if necessary, treated upon arrival in this country. I claim—and I believe that well informed state quarantine officials will support me—that with the personnel and facilities available, the Department cannot safeguard shipments consisting of thousands, even hundreds of thousands, of plants. Nursery stock released by the Department after inspection may be affected with obscure, unknown or undetectable insects and diseases whose presence *cannot* be discerned by port-of-entry inspection. Plants infested with insects known to be present in this country, but not considered as especially injurious, are at times released. Department officials state that in such instances it is up to the state inspectors to

give such treatment as may be deemed desirable. But state officials are without authority to handle plants entered under permit until after they have been delivered by the transportation company to the addressee. It would appear that the federal government is without authority properly to regulate entry of foreign plants so as to prevent entry of foreign plant pests, and at the same time will not permit state officials to take proper action.

This condition with respect to lack of authority delegated to the Secretary of Agriculture may be corrected to a certain extent through adoption by Congress of Senate Bill 1990, recently introduced by Elmer Thomas of Oklahoma, Chairman of the Senate Committee on Agriculture. This Bill, if enacted, will provide authority to limit entries of nursery stock to quantities required for propagating purposes; to require that such stock be grown under quarantine until such time as it has been determined that it is free from plant pests; and, in the event the imported stock is affected with plant pests, to prescribe such treatments as may be deemed necessary.

I strongly urge that the members of the Florida State Horticultural Society, individually and collectively, communicate with their representatives in Congress and insist that they take aggressive action to the end that this amendment be enacted into law. Copies of this Bill have been handed to your President and Secretary.

Enactment of this Bill into law will not in itself close the doors to entry of additional foreign plant pests. Trade follows the flag, and insects and diseases affecting man, animals, and plants follow the trade routes. Florida today is at the threshold of a great expansion of international traffic, particularly by air. Unless there is close collaboration and cooperation between Florida growers on one hand, and those interested in the development of our tourist and commercial industries on the other, the doors will remain open to invasion by alien plant pests. Agriculture and tourists are Florida's chief sources of income. The more we do to expand our agricultural and horticultural industries, the more attrac-

tive our state will be to tourists. The contrary is not true, for when we try to extend our tourist industry by making concessions with respect to our plant quarantine regulations so as to remove what tourists and their supporters consider as unnecessary irritations and delays due to so-called red tape, the well-being of our growers is likely to be adversely affected. Yet there is a constant demand on the part of certain transportation officials and representatives of tourist agencies and communities that our regulations be revised in favor of the tourist. For several years your Plant Board has been fearful of the introduction of some major plant pest as a result of the great expansion in air traffic. Our records show the interception of hundreds of foreign plants and fruits infested with fruit flies and other destructive plant pests. The belief held by public health officials that the danger of an airplane-borne epidemic is real and imminent is substantiated by a recent outbreak of smallpox in a western city that was traced to a soldier just back from Japan. There can be no question of the need for revision of both plant quarantine and public health regulation. But the changes should be upwards, not downwards, even though such action may result in some loss in or annoyance to our tourist trade.

Local chambers of commerce and civic clubs are constantly seeking to improve the economic condition of their communities through the addition of new industries. At the present time there is considerable interest in the designation of certain interior cities as ports of entry for foreign aircraft. I doubt if these public-spirited citizens have stopped to compare the financial advantages likely to accrue from the establishment of such enterprises with the possible economic losses that may result to their agricultural back country through the introduction of foreign pests affecting man, animals, and plants. They should at least make inquiries of proper officials as to whether the state and federal governments are in a position to furnish adequate safeguards that would reduce such risk to the minimum. But at times promoters of such

enterprises become resentful of what they believe to be interference and lack of cooperation on the part of quarantine officials who cannot, because of lack of finances and personnel, support them.

During the month of March our inspectors boarded 467 water- and 2,022 air-craft from foreign countries, and inspected the cargoes, stores, and baggage carried thereon. Two hundred and twenty-nine specimens of insects and diseases were collected from plant material brought in from 37 foreign countries. Fruit fly larvae (*Anastrepha* spp.) were intercepted on five different occasions during the month. The bulk of the ships and airplanes arrived at Miami. During March 40,190 passengers entered here, against 2,089 entering at New Orleans and 2,750 at Brownsville. At West Palm Beach 205 Army airplanes from foreign points were boarded. The Army airfield at Orlando has been closed to foreign planes, and the number of service craft landing at Tampa has fallen off since the war ended. At Pensacola our inspector has been busy supervising the treatment with live steam of sand and soil carried as ballast by ships from Europe. At Jacksonville the time of the inspectors was devoted to checking the movement of nursery stock moved in from other states.

Plans for increased air and water communications between Florida and foreign countries to the south are a matter of concern to the members of the State Plant Board. A dock has been constructed at West Palm Beach for the use of a ferry with a capacity of 26 freight cars that will operate between that place and Havana. Another ferry will operate between Key West and Havana. This vessel will be able to carry 230 automobiles and a number of trailers on each trip. As previously stated, citizens of several interior towns are working towards the designation of their communities as ports of entry for international air traffic. There are now about 20 airlines operating some fifty to sixty planes per day between Florida and foreign countries. Several domestic airlines have indicated their desire to expand into foreign trade.

Competition will be keen. New sources of cargo must be found for the planes on their return trips, and fresh fruits and cut flowers from the tropics are of financial interest to the freight traffic managers of the airlines. Already 1014 boxes of cut orchids have been imported by air.

The development of motor traffic has made enforcement of domestic plant quarantines almost impossible. The great expansion of international air traffic has greatly magnified the risk of invasion by alien plant pests. As your President, Mr. O'Byrne, stated the other night, we cannot successfully combat this invasion by dependence on our first line of defense, quarantine inspection. We must intensify our second line of defense, namely, nursery and grove inspection. I am happy to report that the Board's nursery inspection department has operated effectively and efficiently over a long period of years. This is not true with respect to grove inspection during the past five years. During the war, it was impossible to fill vacancies caused by loss of personnel to the Army and Navy. Since the end of the war, we have found it most difficult to fill the vacancies because of the competition by government and commercial agencies who are in a position to offer prospective employees far greater salaries. There are at present 26 grove inspectors on the roll, 5 short of the number provided by the budget. We believe that a force of 31 grove inspectors can make a complete survey of our citrus plantings once every two years. There may be a question as to whether this is sufficient protection for our vast citrus and allied industries. It is the best, however, your Plant Board can accomplish with funds available.

The barriers in the form of oceans that in the past prevented or retarded dissemination of plant pests from one country to another have been wiped out by the airplane, and Florida is exposed on three sides to invasion by alien plant pests. The task of repelling such invasions is a formidable one. The State Plant Board *cannot* carry on the fight without the help and cooperation of the growers and business interests in our state.

# THE EFFECT OF APPLICATIONS OF CALCIUM AND MAGNESIUM UPON ABSORPTION OF POTASSIUM BY CITRUS

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During the past ten years the fertilizer mixtures applied to citrus groves have changed from the old type N-P-K formulas to those which have added calcium, magnesium and small quantities of the trace or minor elements. Quite generally this mixed fertilizer of guaranteed analysis is supplemented with direct soil applications of dolomite or some other slightly basic, magnesium-bearing material. These changes in fertilizer practice have produced very favorable responses in tree condition and yield performance which may be attributed to the correction of several nutrient deficiencies. Very little attention has been given the effect of these added elements upon the absorption of nitrogen, phosphorus and potassium. These elements (N-P-K) have been carried over into the new fertilizer program with very little if any change or consideration of tree requirements.

The purpose of this discussion is to point out some effects which added calcium and magnesium have upon the absorption of potassium as measured by foliage and fruit analyses, as well as some implications regarding crop production.

The importance and significance of mineral nutrient ion balance is apparent in the results thus far obtained on all of the plots at the Citrus Experiment Station. The interaction of calcium, potassium and magnesium is observed as a repressive effect of the cation (Ca, K or Mg) being increasingly absorbed upon the absorption of the other two; that is, as the absorption of one increases, that of the other two decreases. For example, the

curves in Figure 1 show the effects of increasing the rate of potash fertilization from zero to 16 units per ton upon the absorption of potassium, calcium and magnesium. The potassium content of the leaves increased as the amount of potassium in the fertilizer increased. Although calcium and magnesium were uniformly applied to all plots, it is quite apparent that less and less of these two elements were absorbed as the absorption of potassium increased. Furthermore, the total amount (Ca+K+Mg) of these elements absorbed decreased as the amount of absorbed potassium increased. Thus increased application and absorption of potassium repressed the absorption of calcium and magnesium. If the supply of available magnesium had been lower in these plots, it is conceivable that the highest rates of potash fertilization would have induced symptoms of magnesium deficiency.

With higher levels of available calcium and magnesium in the soil, greater amounts of these two elements would have been absorbed and the absorption of potassium would have been lower at all rates of potash application. However, the slope of the curves would have remained essentially the same. The curves of Figure 2 serve to illustrate this point. In this experiment, Block V, absorption of potash at different rates of application has been determined at two different levels of calcium and magnesium fertilization.

In the fall of 1939 the old N-P-K fertilizer program which these plots had received for sixteen years was slightly altered for the purpose of making a comparison of the effects of calcium and magnesium upon the growth and production of Duncan grapefruit. The plots receiving 3.0, 5.0 and 10.0% K<sub>2</sub>O fertilizer remained unchanged. Plot No. 6 which

had received 3.0% in the spring, 5.0% in the summer and 10.0%  $K_2O$  in the fall was changed to a check (0.0%  $K_2O$ ) plot. Calcium and magnesium in the form of dolomite and water-soluble magnesium were uniformly applied to a section of all plots at right angles to or across the potash plots. All of the plots received copper, zinc and manganese in the form of nutritional sprays or as fungicidal sprays for the control of melanose. Thus the principal difference in treatment within each potash plot, shown in Figure 2, was the absence of added calcium and magnesium in one section (broken line) and the addition of these two elements in the other section (solid line).

The amount of potassium found in the leaves increased as the amount applied in-

creased in both sections of the plots, which agrees with the results shown in Figure 1. However, the amount of potassium (K) absorbed at each rate of application was less where calcium and magnesium were added than where the supply of these elements was low (broken line). Likewise the applications of dolomite and water-soluble magnesium resulted in greater absorption of calcium and magnesium and repressed the absorption of potassium. The foliage composition in the check plots (0%  $K_2O$ ) showed very high calcium, which was due to the extremely low supply of potash in the soil. Even in the section (broken line) where the pH is low and the only supply of calcium was superphosphate, the calcium content of the foliage was greater than that found when additional calcium had been applied (solid line) in the presence of only 3.0%  $K_2O$ . The curves of Figure 2 illustrate the effect of the new fertilizer program, in which calcium and magnesium are used for controlling pH and correcting magnesium deficiency, upon the absorption of potassium. The Duncan grapefruit trees are in much better physical condition and have produced more fruit where calcium and magnesium have been added.

As further evidence of the repressive effect of applications of calcium and magnesium upon potassium absorption, the averaged results of several sets of samples are shown in Table 1. The averaged results of 1935 and 1936 were obtained before a check plot was set up in 1939. The 3 and 10%  $K_2O$  duplicate plots have received this treatment for more than twenty years and may be used for comparison. The 1942 results were obtained from sections of the plots receiving additions of dolomite and water-soluble magnesium. The absorption of potassium is 20 to 25 milliequivalents lower where calcium and magnesium were added, which is approximately a 30% reduction. The amount of potassium (61.1 M.E.) absorbed from the application of fertilizer containing 3 units  $K_2O$  on soil low in calcium and magnesium is about equal to the amount (59.6 M.E.) absorbed from the application of 10 units of  $K_2O$  on soil to

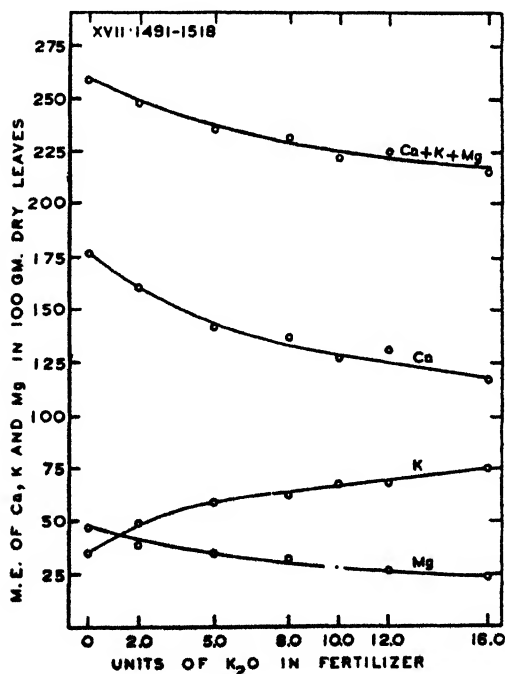


Figure 1. Graph showing the effect of different rates of application of muriate of potash upon the amount of potassium, calcium and magnesium in orange foliage.

which calcium and magnesium had been added. The lower absorption of potassium is off-set by higher absorption of calcium and magnesium.

From these foliage analyses, one may conclude that the old fertilizer program with high potash, low calcium and deficient magnesium gave inefficient utilization of nutrients and thus low crop production. Also, potassium was being absorbed in "luxury consumption," that is, considerably in excess of an efficient requirement. On the other hand, the new fertilizer program, in which additions of calcium and especially magnesium are made, have so increased tree vigor and crop yield that the apparent "luxury consumption" of potassium is eliminated where fertilizer containing 5.0 units of  $K_2O$  is applied. With lesser amounts of potash in the fertilizer, the trees show indications of potash hunger.

The amount of these elements, especially potassium and magnesium removed in the fruit crop are important from the standpoint of crop requirement. The curves in Figure 3 show the milli-equivalent composition of 100 grams of whole-fruit dry matter. The amount of potassium found in the fruit increased as the rate of  $K_2O$  applied increased, while the amount of calcium decreased. The amount of potassium in the dry matter of the fruit is of about the same magnitude as that found in the leaves. Calcium and magnesium are much lower in fruit than in the leaves. It is interesting to note that the fruit contained slightly more potassium where calcium and magnesium were applied, which is the opposite of the results obtained from the leaves on the same trees (Figure 2). This may be due to the presence of a greater number of leaves in the proximity of each fruit, resulting from the correction of magnesium deficiency.

In order to determine the amount of potassium removed in the fruit, the total average yield per tree was computed for a four-year period, 1940-44. The average fresh fruit yields per tree are shown in the graphs of Figure 4 for each potash treatment with and without

the additions of calcium and magnesium. The old fertilizer program, which is represented by the open column, produced the best average yield with 3.0 units of  $K_2O$  in the fertilizer. In the presence of added calcium and magnesium, the 5.0% treatment produced the best average yield for the four-year period. With one exception, sections of all plots receiv-

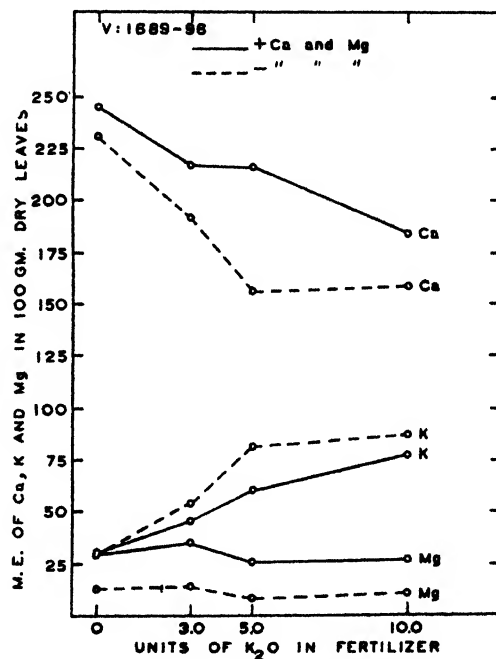


Figure 2. The effect of different rates of potash fertilization at two different levels of treatment with calcium and magnesium upon the composition of Duncan grapefruit foliage.

ing added calcium and magnesium produced significantly greater yields of Duncan grapefruit.

Having determined the fruit composition (Figure 3) and the total amount of fruit produced per tree (Figure 4), the amounts of potash applied to the soil and removed in the fruit during the 4-year period were computed (Figure 5). Where no potash has been applied

since the summer application in 1939, it is apparent that the fruit crop has continued to remove potassium from the trees. Although the potassium content of fruit (Figure 3) is low where no potash was applied, the average crop produced per tree over the four-year period was sufficient to remove 3.4 pounds  $K_2O$  with the old program (A) and about 6.0 pounds of  $K_2O$  with calcium and magnesium added (B). With the exception of the results obtained where 3.0 units  $K_2O$  were applied, the graphs show that addition of calcium and magnesium to the soil has, through greater crop yields (Figure 4), converted more po-

plied (B) is almost equal to the amount of  $K_2O$  applied in the fertilizer. Thus it may be concluded that 5.0 units of  $K_2O$  applied three times a year is somewhat low for both vegetative growth and crop production of these grapefruit trees. The pounds of  $K_2O$  applied

TABLE 1. THE COMPOSITION OF DUNCAN GRAPEFRUIT FOLIAGE SHOWING CALCIUM, POTASSIUM AND MAGNESIUM IN MILLIEQUIVALENTS PER 100 GRAMS OF DRY LEAVES.

UNITS $K_2O$ IN FERT.		0	3	10
AVERAGE OF NINE ANALYSES IN 1935 AND 1936 (- Ca AND Mg)	Ca	---	123.5	99.4
	K	---	61.1	83.1
	Mg	---	13.5	13.2
	SUM	---	198.1	195.7
AVERAGE OF THREE ANALYSES IN 1942 (+ Ca AND Mg)	Ca	232.5	198.2	184.1
	K	35.1	42.2	59.6
	Mg	33.8	31.6	27.7
	SUM	301.4	272.0	272.4

tassium into fruit, which, of course, was removed from the tree.

The results obtained with 5.0 units of  $K_2O$  in the fertilizer illustrate the difference in potassium requirement for crop production between the old N-P-K program with nutritional sprays (A) and the new N-P-K-Ca-Mg program with nutritional sprays (B). The amount applied in 5.0% fertilizer is approximately double the amount required for fruit production (A). The excess potash was either absorbed in luxury consumption or lost through leaching. In contrast, the amount removed in fruit where calcium and magnesium were ap-

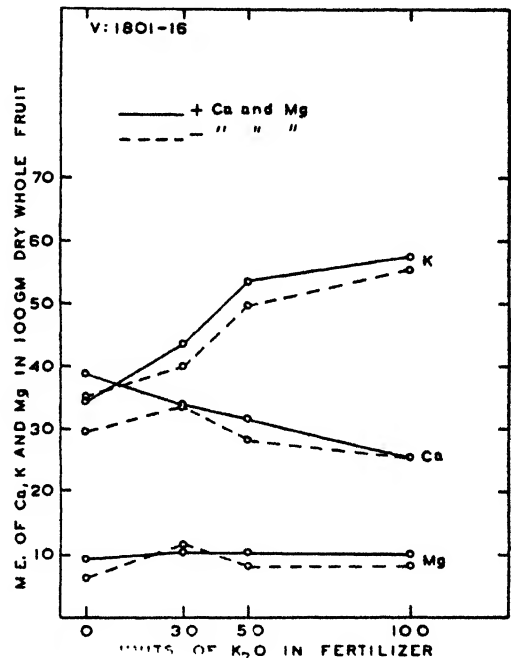


Figure 3. The effect of different rates of muriate of potash application at two levels of calcium and magnesium treatment upon Duncan fruit composition.

plied in 10.0% fertilizer was apparently in excess of the amount needed for growth and crop production. In fact it has been shown that 10%  $K_2O$  in the fertilizer applied three times each year repressed undesirably the absorption of calcium and magnesium, which are known to be beneficial to growth and yield.

These results show that grove practices and fertilizer programs which over a period of years will induce increased crop yields through the correction of a deficiency of one element may so increase the demand upon the supply





ceived 5.0 units of  $K_2O$  with 3.0 units of nitrogen in the fertilizer three times each year. The fruit produced accounted for only 44.7 percent of the potassium added in the fertilizer over a 4-year period. With the new fertilizer program (N-P-K-Ca-Mg-Mn-Cu-Zn), the results with 5.0 units  $K_2O$  fertilizer under the same conditions showed that the crops of fruit produced accounted for 89.6 percent of the added potassium. Thus these results indicate that crop production is a major factor to con-

5.0 units of  $K_2O$  in a fertilizer with 3.0 units of nitrogen applied three times each year apparently will not supply adequate potash for fruit production and vegetative growth on soils where leaching is an important factor. Over a period of years, the potash supply would

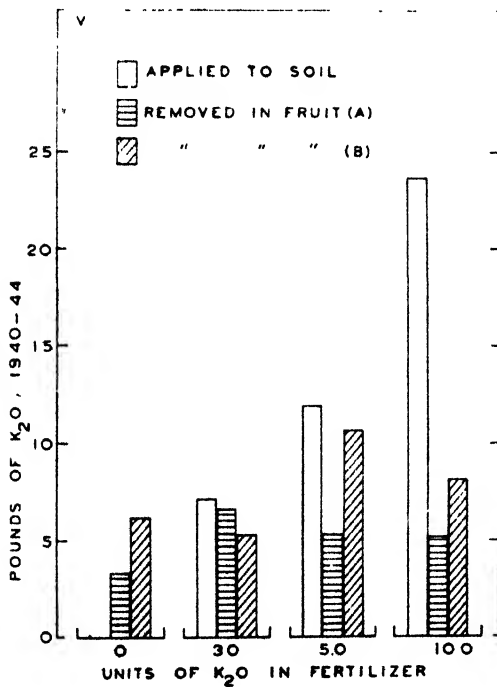


Figure 5. Graph showing total amount of potash applied per tree, and the total amount of potash removed in fruit at two levels of calcium and magnesium (A and B) for a four-year period, 1940-44.

sider in determining the potassium requirements. Due to the greater yields obtained with the present recommended fertilizer program,

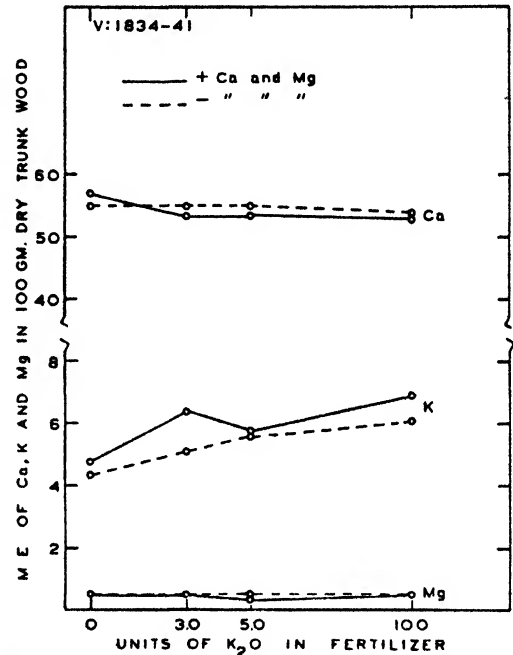


Figure 6. The effect of different rates of potash application at two levels of calcium and magnesium (A and B) upon trunk wood composition.

probably become the "limiting factor" in crop production. The present recommendations call for the application of 8.0 units of  $K_2O$  with 3.0 and 4.0 units of nitrogen in fertilizers for summer and fall application. In the spring top dressers, the ratios of N to  $K_2O$  are approximately 1.0 to 1.0 and the formulas usually analyze 8-0-8-6-1-1/2 (N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O-MgO-MnO-CuO).

# CITRUS RESEARCH ON THE EAST COAST OF FLORIDA

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Early in 1942 the Citrus Experiment Station entered upon a research program on the East Coast designed to investigate problems in citrus culture peculiar to that area. The first step in this program was a rather thorough survey of the grove conditions and existing cultural practices on the East Coast so as to more intelligently set up any research projects. During the course of this survey a rooting study of citrus growing on several of the principal and representative soil types was made to gather information on the variations in depth and extent of rooting under various conditions. It was found that the principal root zone was in the surface 12 inches, with few roots below 18 inches. Little rooting was found across the middles of bedded groves, except those with very shallow furrows. A survey was also made of the chemical composition of the principal soil types planted to citrus, in an attempt to arrive at their relative fertility and to determine, insofar as possible, what recommendations probably should be made in a general way concerning fertilization and other cultural practices. As a rule it was found that the coastal soils were relatively high in exchange capacity, exchangeable bases, and nitrogen, but averaged somewhat lower in available phosphorus than the Ridge citrus soils. Because of calcareous material in the root zone or so closely underlying it as to have an influence on its composition, the ratio of exchangeable calcium to other exchangeable bases was frequently unfavorably high.

A rather satisfactory spray program for coastal areas had been developed previously, primarily through some extensive investigations conducted in the Vero Beach section by Mr. W. L. Thompson, Entomologist, and Dr.

George D. Ruehle, Pathologist of the Citrus Station. The spray recommendations for insect and disease control contained in Schedule A of the Better Fruit Program were based largely on the results of these investigations.

With the exception of this spray program a great diversity of opinions was found among the growers as to what constituted the best, or even satisfactory, cultural practices. It soon became evident that many problems needed attention and that the same problems were not necessarily of paramount importance in each section. Work could not be initiated on all problems at the same time. The ones selected for immediate attention were those which gave the most promise of yielding information which would in turn yield the greatest net cash returns to the industry in the area as a whole.

Throughout the entire area, and especially from St. Lucie County north, moisture conditions in most groves had become increasingly critical as the trees increased in size. Of the factors concerned in the production of citrus which can be at least partially controlled by the grower, none is of greater importance than the maintenance of proper soil moisture. Consequently water relation investigations were started in the spring of 1942, with Indian River County selected as the center of the work because of its variety of soils, which were more or less representative of the principal soil types planted to citrus elsewhere in the area.

Most of the soils planted to citrus in the Davie section and some of those in citrus around Lake Okeechobee are unique because of their high organic matter content. Nutritional problems on these organic soils are widely different in many respects from those on the more mineral type soils on which a majority of citrus in this state is planted and towards which most nutritional research has been directed. For several years the Everglades Experiment Station has conducted work with the 3 major elements on citrus on these organic

soils. However, additional work with these as well as the minor elements was urgently needed. Since the Everglades Station was not prepared to handle additional work on citrus, the Citrus Station established a series of fertilizer and nutritional spray plots near Davie after having first made a thorough chemical examination of the soil.

Other research projects have been established and conducted in the order of their apparent need when facilities and time permitted. These have for the most part been given secondary attention in order to expedite work on those problems of major importance, and may or may not be mentioned later in this paper.

#### WATER RELATION INVESTIGATIONS

During 1942 an investigation was made in the field near Vero Beach on the efficiency of the "furrow" type irrigation commonly practiced in bedded groves in the artesian areas of the East Coast. From this there were strong indications that little water moved into the root zone as a result of the average irrigation, except in sandy soils. A complete report was given on this before this Society at the 1943 meeting (7) and will not be gone into in detail again. It is sufficient to say that it was not unusual to find trees on the heavier soils wilting during irrigation or just after having been irrigated.

The next step in this work was to set up a series of 12 plots on soils which represented the range in citrus soil texture and grove conditions of that area. The purpose of these plots was to make a thorough survey of the moisture conditions that actually existed in the groves over a period of relatively normal weather, as well as wet and dry weather, when drainage and irrigation were involved. Rain gauges were maintained on each plot and irrigation records secured in order to evaluate the influence of both rain and irrigation on soil moisture. Periodic sampling and moisture determinations were made by the oven-dry method. This method was a more satisfactory measure of the efficiency of an irrigation than the one used previously because increases in moisture due to both gravitational and capillary

movement of water were measured. In the earlier work only water moving into the soil by gravity was actually measured.

In conjunction with this field work, moisture tension studies were made and soil moisture retention curves plotted for each soil to determine its "available moisture-holding capacity" and "air capacity." Available moisture in that portion of soil moisture between the zone in which drainage from the soil has practically ceased (actual field capacity) after having been saturated and the zone in which plants permanently wilt in a saturated atmosphere unless water is added to the soil (wilting point). The available moisture-holding capacity is the amount of available moisture a particular soil will retain, once it has been supplied through rain or irrigation, and is usually expressed as the percentage by volume of the soil. The air capacity of a soil is the percent by volume of air in a soil when soil moisture is at the field capacity for that particular soil.

The possible practical applications of such information are several. In order to irrigate most effectively and economically the actual field capacity and the wilting point of the soil in question should be known and the soil moisture maintained between these two values. Irrigation should be done before the wilting point is reached and only enough water applied to bring the moisture of the entire body of soil in the root zone to approximately the actual field capacity. Water supplied in excess of this drains away rapidly and benefits the plants little, and excessive leaching of nutrients results. The effects of soil moisture at or below the wilting point are obvious and well known. An idea of the relative abilities of various soils to retain moisture, once it is supplied, can be obtained by comparing their available moisture-holding capacities. In order that there will be no retardation of root growth or functioning, and for soil sanitation reasons, it is essential that a portion of the soil pore space be filled with air. Perhaps roughly an ideal condition would be that in which about half the total pore space was occupied by air, the other half, of course, be-

ing occupied by water. There is little question, however, but what most plants thrive in most soils with rather wide variations in the air:water ratio. An air capacity of at least 10% by volume has been considered in a general way to indicate the minimum in adequate drainage.

With the water table between 4 and 5 feet below the surface (average normal weather water table for the Vero Beach section) the available moisture-holding capacity of the surface 6" of soil from these plots ranged from 4.3% by volume (0.26") for a Leon fine sand to 9.4% (0.56") for a Manatee fine sandy clay loam. The 6-12" layer of these same soils had a value of 3.5% (0.21") and 10.8% (0.65") respectively, and the 12-18" layer 2.7% (0.16") and 11.5% (0.69"). If the water table was dropped a couple of feet (average drought water table for the section) the available moisture-holding capacities of these soils were reduced on an average of 21% for the Leon soil and 13% for the Manatee soil.

Interpreting these data on the basis of the amount of available moisture that could be held in the surface 18" after it had come to equilibrium with the forces tending to drain it, with the normal weather water table we find the light Leon soil could retain a total of 0.63" or approximately 17,000 gallons of water per acre-18". It is roughly estimated this would maintain an average mature grove with a medium cover crop from 1 to 2 weeks before wilting occurred. If drought had lowered the water table a couple of feet the amount that could be retained might be sufficient for only 5 to 11 days. If there was considerable rooting below the 18" level or cross rooting into the furrows, the period would likely be proportionately longer. In the much heavier Manatee soil a total of 1.9" or 51,000 gallons of water could be retained in the surface 18" over the normal weather water table. Estimated on the same basis as for the Leon soil, this would satisfactorily support the trees for about 3 to 6 weeks, depending upon depth and spread of rooting. Lowering the water table 2 feet might re-

duce this to something between 2½ and 5 weeks.

The air capacity at the higher water table ranged from about 16% in marl soil to about 38% in a fine sandy loam. These values increased slightly with the lowering of the water table. In either case drainage would be considered adequate. Further analyses of these data from the soil moisture retention curves indicated, at least theoretically, that a water table at 3 feet would be approximately the maximum height to which it could be raised and yet insure ample drainage in the lower portion of the 18" root zone in the soils examined.

Similar moisture tension studies made on organic soils from the Davie area showed them to have, on the average, an available moisture-holding capacity of approximately twice that of the soils from the Vero Beach section. The moisture-holding capacity and the air capacity both increased with an increase in organic matter, although not in proportion and at lower and varying rates. The air capacity of these organic soils was found to be relatively high even with a water table at 3 feet. For the sake of further comparison, the light sandy soils of the Ridge were found to have a slightly lower available moisture-holding capacity than the lightest soils tested from the East Coast. However, because of more extensive rooting generally in the Ridge, this capacity is estimated to be sufficient for about 2 weeks for the average mature grove. The sands of the Ridge also have a relatively high air capacity.

It should be understood that a high or a low available moisture-holding capacity is not synonymous with high or low actual soil moisture. The available moisture-holding capacity is only a measure of the soil's ability to retain moisture, against the forces tending to drain it, once it has been supplied through rainfall or irrigation. It is obvious that in order to benefit by a high available moisture-holding capacity, over a low one, that more water would have to be supplied. In fact many soils with high available moisture capacities also have high wilting points. With soil

moisture below the wilting point a given amount of water added to such soils might not result in as much available moisture as on another soil with a lower available moisture capacity, equally below the wilting point, but having a lower wilting point. The actual air capacity of any soil is inversely proportional to its actual water content, i. e., the greater the water the less the air.

The field studies gave a good broad general picture of the relation between rainfall and/or irrigation and the moisture present in these soils under field conditions. Conclusive evidence was also obtained that the movement of water into and through these soils, particularly that portion moving primarily by capillarity, was slow except in sands. Irrigation, as generally practiced by flooding the tree row middles, usually resulted in an increase in soil moisture to only a fraction of the field capacity. Only occasionally was it found to have reached field capacity and then usually in the deeper layers of soil below the level to which water had been raised in the middles. Not infrequently the moisture remained below the wilting point in heavy soils after irrigation, even in the 12-18" soil layer. In one grove observed, when the moisture was below the wilting point in the surface 6", but above it in the deeper layers, the trees did not recover from wilting overnight. This occurred during nights of high humidity as well as those with low humidity, as evidenced by dew or its absence. From these observations it appeared that the trees were restricted in their rooting primarily to the surface layer. There was not sufficient rooting in the deeper layers to prevent wilting, even in a saturated atmosphere. Reasonably well distributed rainfall, if only in moderate amounts, was much more effective in maintaining favorable soil moisture than the best regulated irrigation by flooding observed in this study.

The significance of these findings can be briefly summarized. If flooding irrigation is to be practiced effectively the water must be brought high on the beds so as to practically cover the surface. Then gravitational forces as well as capillary forces act to distribute water through the soil. The period of flooding

should not be prolonged, 24 hours should be about the maximum, and certainly not longer than 36 hours. Longer periods may result in root damage in the deeper layers of soil, especially in light soils because of the more rapid expulsion of air from light than from heavy soils. This would usually mean that the water would have to be confined to fewer tree rows to allow getting sufficient water on and off a given area quickly. In some cases more wells would be advisable. The alternative is irrigation by some sort of sprinkler system. A few such systems are now in operation and apparently paying good dividends. We have recently set up an irrigation experiment in cooperation with Mr. T. A. Peebles and Mr. J. M. Hopwood, who are furnishing the equipment, labor and grove, at Vero Beach. In due time this experiment should yield some accurate information on the net returns from sprinkler irrigation as compared to both no irrigation and flood irrigation.

Within the past year or so there has been considerable agitation in the Vero Beach Drainage District to conserve soil moisture by raising and controlling the water table in the district with a series of locks or gates in the drainage canals. The Citrus Experiment Station has been approached for advice on this rather highly controversial subject. Little fundamental data were available concerning the level at which a water table should be held for optimum results with citrus. The first step in securing such data was the installation of a series of 20 water-table wells in a grove in the drainage district. These were installed through the cooperation of Mr. E. E. Carter, Indian River County Engineer. Periodic measurements are made to trace the fluctuations of the water table under present conditions. Later it is proposed to raise and control the water table in a portion of the grove to compare the response of trees in this portion with those in the uncontrolled portion of grove. Similar water-table well installations will be made throughout the district as rapidly as labor permits.

Incidental to securing rainfall records for the moisture study plots something as to the

magnitude of rainfall variation within a limited area was obtained. The 12 plots were distributed so as to encompass an area of approximately 35 square miles. Rainfall on individual plots from November 1, 1943 to November 16, 1944 ranged from 52.84" to 64.92", a difference of 12.08". The plot receiving the maximum and that receiving the minimum were about 5 miles apart. Approximately 10 to 15 inches of the rainfall for the period occurred during a 5-day period accompanying the hurricane of October 16, 1944.

To trace any tendency towards an increased saltiness in the artesian irrigation waters on the East Coast about 130 index wells, distributed from south of Ft. Pierce to Oak Hill, are analyzed annually for salt. This work has been reported on in some detail previously before this Society (6). The results of these tests indicate a slight general increase in saltiness to be taking place. None of the increases has been sufficient as yet to render water unfit for irrigation or spray purposes where it was safe at the beginning of these tests in 1942.

#### NUTRITIONAL EXPERIMENTS

Recognizing the need for citrus nutritional research on the sandy-peaty muck soils of the southeastern Everglades area a number of years ago, the Everglades Experiment Station, under the direction of Dr. R. V. Allison, established a series of fertilizer test plots near Davie in 1934. The primary object of these plots was to determine the relative response to phosphate fertilizers, when applied in various amounts and from various sources. Some attention was also given to nitrogen and potash fertilizer levels. There were 16 different treatments included in this experiment. The results obtained from these treatments, up to that time, were discussed by Neller and Forsee (5) at the 1941 Horticultural meeting. Forsee and Neller (2) reported on the response to phosphate treatments secured on these plots at the 1944 meeting.

In a reorganization of citrus work by the Experiment Station, this experiment was transferred to the Citrus Experiment Station

for handling early in 1945. Based on statistical analyses of the annual production data from these plots for 9 years, certain major conclusions may now be drawn. Phosphates in relatively normal amounts (an average of 1.08 pounds of  $P_2O_5$  per tree per year for the past 6 years on Valencia trees now 17 years old) gave results as good as, or better than, phosphate treatments in greater or lesser amounts. Trees never receiving direct applications of phosphate fertilizers, but possibly in recent years having secured small amounts of phosphate by cross rooting to adjacent phosphate-treated plots, yielded statistically less fruit and fruit of inferior quality and smaller sizes than did trees receiving normal amounts of phosphate fertilizers. Phosphate at twice the normal amount did not generally yield as well as the normal amounts, although only one treatment was statistically lower. In this latter case a copper relationship evidently was involved. Two of the phosphate treatments at twice the normal amount caused excessive ammoniation for several years in succession. This trouble was practically eliminated in one year with a copper spray. The implications of this phosphate-copper relationship have been discussed by Forsee and Allison (1) and by Jamison (4). There was no significant difference in yields from the various phosphate sources when used in approximately equal amounts with respect to available  $P_2O_5$ . These sources were triple superphosphate, raw ground rock phosphate, basic slag, colloidal phosphate, and dicalcium phosphate. A limited amount of evidence was obtained indicating that no statistical increase in yield over zero nitrogen fertilizer was secured through nitrogen fertilizers in amounts ranging each year from 0.36 to 1.44 pounds of N per tree per year for the past 6 years. The trees receiving no nitrogen in the fertilizer probably did secure small amounts of nitrogen from adjacent nitrogen treatments after they became large enough to cross root. Any difference in fruit color was usually in favor of the minus nitrogen treatments. Potash treatments were at the average rates of 2.16, 4.32 and 8.64 pounds of  $K_2O$  per tree per year for

the past 6 years. There was no statistical difference between any of the potash treatments. In the absence of treatments less than 2.16 pounds one can only speculate on a lower level at which potash would become a controlling factor to reduce yields appreciably. Although not statistically different, the higher potash treatments were rather consistently higher yielding. It appeared that the potash level which probably would have yielded the maximum net cash returns from these trees for this 6-year period was between 2.16 and 4.32 pounds per tree per year.

A point brought out by these experiments which has nothing to do with production but is worth noting, particularly by those concerned with field plot research, is that it was not until the fourth harvest that any statistical difference in yields from the various treatments appeared. This was after the trees had been under experimental treatment for over 6 years. Thus it emphasizes the necessity of allowing ample time for field fertilizer tests with tree crops to "mature" before attempting conclusions.

During the past few years there has been a tendency towards an increased use of nitrogen in citrus fertilizers in the Davie section. From the previously discussed nitrogen plots, field observations, soil nitrate-nitrogen tests, and the nitrogen analyses of leaves from these plots, which Dr. Fudge made recently, there is considerable evidence that generally little or no response to nitrogen fertilizers could reasonably be expected with citrus on Davie soils having an organic matter content of about 20% or higher. This would include a large majority of the citrus plantings in that section at present. More conclusive evidence on this point was needed. Consequently in 1944 a rather extensive experiment was established in a 17-year old Valencia grove to further determine the response to nitrogen applied in various amounts and at different seasons on soils ranging in organic matter from about 10% to 60%. Last year's harvest data and an estimate of the fruit on these plots recently has shown nothing of significance with respect to either time

or amount of nitrogen applied. But as just pointed out, it is hazardous to attempt conclusions for citrus nutritional experiments with only a few years results.

Within the past year or so other experimental plots have been established cooperatively with Mr. Floyd L. Wray and Mr. Walter Stirling in the Davie area. These experiments are designed to test the response of citrus to magnesium, manganese, copper, zinc, and boron. With the exception of the first, all will be tested as sprays as well as fertilizers. Further tests are also being made with N.P.K. None of these have been in progress sufficiently long to warrant further comment.

Early in this paper it was mentioned that the ratio of exchangeable calcium to other bases was frequently found to be unfavorably high in some of the East Coast soils. Dr. B. R. Fudge (3) has just told you something of the evidence of interactions between calcium, magnesium, and potash in the leaves and the relationships and mechanism involved because of the ratio of these elements in the soil. The analyses of soils taken throughout the East Coast citrus belt have shown that these unbalanced conditions are likely to exist wherever calcareous materials are within a couple of feet of the surface. High exchangeable calcium in relation to the other bases evidently has a suppressing effect on the intake and/or utilization within the plant of the other bases.

A favorable soil ratio of calcium:magnesium for citrus is not greater than 15:1. Bronzing is not yet prevalent in the Davie section, probably partly due to the relatively high native magnesium content of the soil and partly to generally light crops and the predominance of Valencias which have a relatively low magnesium requirement because of their few seeds. Also, most of the groves are comparatively young, so that cropping-out has not become a factor. However, the magnesium content of 13 composite Valencia leaf samples taken west of Davie recently was found to be only about one-half that generally considered to be normal for good consistently bearing trees. The



trees from which the leaf samples were taken showed no bronzing. The exchangeable magnesium content of the 13 corresponding soil samples taken in conjunction with the leaf samples averaged about 100 pounds per acre-6 inches. This would be considered ample in a soil with calcium in the proper proportion. But the exchangeable calcium in these soils averaged approximately 3000 pounds per acre-6 inches, which gives a 30:1 ratio. This condition is also evidently manifesting itself in some parts of the Turnbull Hammock section. Magnesium deficiency symptoms have been prevalent in the foliage of many groves in the Hammock for the past several seasons although they are on soils with a relatively high magnesium content. It seems quite likely that in the very near future it will be found profitable from the production standpoint to use considerably more water-soluble magnesium in the fertilizers on these soils, as well as on many others high in calcium, than has been used in the past. In some severe cases a few applications of fertilizer with 5 or 6% magnesium (MgO) may be warranted until a favorable Ca:Mg ratio is established.

About 6 or 7 years ago many growers still questioned the advantages of spray applications of zinc and manganese over soil applications, even on soils of high pH. More as a demonstration of the relative effectiveness of the two methods of application than as an experiment, Dr. A. F. Camp and Mr. W. W. Lawless laid out a series of plots in a bearing Valencia grove with a soil pH of about 7.5 on Merritt Island. Soil applications of sulfur and various combinations of sulfur, zinc sulfate, manganese sulfate, iron sulfate, and borax were given, as well as a zinc-manganese spray, to individual plots in triplicate annually for 4 years. All plots, including 4 controls, received the usual mixed fertilizers, an annual copper melanose spray, and periodic sulfur sprays and dust for mite control. At the third harvest after treatment was started, there was a marked difference between the zinc-manganese sprayed plots and all other plots with respect to tree condition and yield. All except the sprayed plots were decidedly zinc and

manganese deficient. The average annual production per tree on the zinc-manganese sprayed plots for the last two years of the demonstration was 0.55 of a field box more than the next highest yielding treatment, 1.08 field boxes more than the controls, and 1.33 field boxes more than the average of all other treatments including controls. With the exception of the spray treatments, none of the treatments was consistent in performance rank for the two years. More complete data on these results have been published elsewhere (9), (10).

#### SOME MISCELLANEOUS WORK

A salt survey of the waters of the Davie canal system was made about a year ago. The salt contents of both the North and South New River Canals below the locks, as well as many of the laterals below the locks, were high. In the two main canals adjacent to citrus groves, salt contents of 5000 to 10,000 p.p.m. were common. One sample taken about 1/4 mile from a young grove analyzed 25,000 p.p.m. Some of the laterals alongside groves tested 8000 to 9000 p.p.m. A few water and soil samples taken from borings in groves near canals showed there had been little salt intrusion or accumulation. Above the locks the canals were practically fresh, about 60 to 110 p.p.m. Little rainfall in the Davie-Okeechobee region for several months previous to the survey had resulted in decreased flushing with fresh water and a gradual encroachment of saline waters through tidal effects. Thus the salt content of these canals is probably not always in these magnitudes. However, the water is very likely frequently too salty below the locks for safe irrigation. With citrus 2000 p.p.m. salt in irrigation water is considered dangerous. Shallow wells below the locks used for irrigation might salt-up under the recharge demands of heavy pumping. Although no salt damage was reported from that section on citrus it seems advisable that the growers be informed of the condition.

Within the past year some time has been devoted to exploring the possibilities of controlling noxious plants in groves and grove

water sources with 2,4-D sprays. A report on the progress made thus far with this will be given in another paper at this meeting (8).

In addition to these research projects, it should be mentioned that the Citrus Station cooperates, insofar as possible, with growers on the East Coast whenever they encounter some acute problem which cannot wait for routine research for a solution. In such cases the men from the Station who are best fitted to serve usually try to visit the scene of the trouble and make recommendations or conduct whatever tests are necessary for a solution.

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## USE OF DDT TO CONTROL THE LITTLE FIRE ANT

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# PREVENTIVE SPRAYS FOR MITE CONTROL ON CITRUS

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The three common species of mites infesting citrus in Florida have been here for many years, yet there always seems to be room for improvement in the method of control. Aside from the various insecticides which may be used, several methods or schedules can be followed for mite control. Some groves follow a rather definite or predetermined schedule while others wait until the mites become more or less numerous before control measures are taken. The control of mites has been more effective in the experimental work as well as in commercial operations where a more or less definite schedule has been followed. However, in following a fixed schedule it is necessary that the timing of the individual applications be so arranged that the longest period of control possible is obtained without injury from the mites, regardless of the species. Over a period of years it has been found that sprays of a preventive nature have been more effective in reducing injury than sprays which were applied after the mites had already become abundant.

At present there are no materials on the market which possess a residual toxicity such that they will prevent reinfestation of mites for any prolonged period of time. However, by reducing a very light infestation to an absolute minimum, several months may elapse before large populations develop. The term "preventive sprays" is used in this paper to refer to this latter type of situation. The citrus industry as a whole is not run in small units of 5 to 50 acres as it was 20 years ago. Most of the Cooperative Associations now have their own production departments, and other groups have been formed either as cooperatives or

corporations to take care of production. Thus, from 1000 to 8000 acres are under the same supervision and are cared for with the same equipment. Since any one of the individual groups is probably inadequately equipped to spray or dust a large acreage in a short period of time, it is desirable to plan a schedule whereby large acreages can be treated with limited equipment. This must be accomplished in such a manner that mite control can be maintained during the interval between applications. The following is a discussion of materials which can be used and the timing of the applications to prevent heavy infestations of purple mites, six-spotted mites, and rust mites at the time when they are likely to cause the most severe damage.

The purple mite *Paratetranychus citri* has become a pest of major importance. Purple mites are usually most abundant during the period between November and June. During August, September, and October it is sometimes difficult to find them, but if a diligent search is made a few mites can be found unless some effective material has recently been applied for their control. If a spray or dust containing a material which is toxic to purple mites is applied during late October, November, or December, the chances are that a purple-mite infestation will not develop before spring. The idea of the preventative spray is to reduce a sparse population to such a low level that it will take considerable time for it to build up to even a light infestation. Thus, groves that have been sprayed in October or November with an oil emulsion for scale control are usually not infested with purple mites until March or later. In several groves where checks were made only an occasional mite could be found at the time the spray was applied. The fact that a later infestation did not occur in these groves was not due to any residual effect of the oil, but resulted rather be-

cause a light infestation (so light that it would not be noticed in a routine check) was reduced to such a low level that the mites could not become abundant until late spring. Early November applications of wettable sulfur and DN<sup>1</sup> have given much the same results. During the cool fall and winter months the life cycle of the mites is longer than during warm weather. Thus, a reinfestation is slow to develop where the population has been reduced to a minimum by an effective spray in the fall or early winter.

Since purple mites are not very abundant and in many groves are difficult to find in late October or in early November, many growers have not attempted to use control measures at that time of the year. One reason that a light infestation may not be noticed in the late fall is because most of the mites are on leaves and twigs near the tops of the trees and are not observed when a routine inspection is made. Often, in the fall of the year, no mites can be found on the leaves and twigs which are within reach from the ground. However, at the same time, there may be a moderate infestation in the top branches of the trees. Where sulfur sprays are needed for rust-mite control in the fall of the year, the addition of some effective miticide such as DN is good insurance against an infestation of purple mites during the winter months. Such programs have been used experimentally and commercially with very good results.

The value of the fall and winter sprays was well demonstrated in the spring of 1946. Where DN or oil was used during November, December, or January, purple-mite infestations remained at a low level until after mid-April. However, where control measures were not taken, moderate to heavy infestations were often encountered in groves about the time the spring growth started to flush. Since heavy purple-mite infestations did not generally develop until January and February, some growers made no attempt to control the mites in December, and in many cases no DN was

added to the dormant nutritional spray. Failure to use some miticide during the fall or in the January nutritional spray resulted in heavy infestations at the time when the new flush of growth had started and the trees were in bloom. DN could not be used because of the danger of injury to young foliage and flower buds. An oil spray could have been used and was used in some cases, but it meant an extra spray since it was too early to use copper for the maximum control of melanose. Such difficulties might have been avoided if control measures had been taken during the dormant season before heavy infestations developed.

The six-spotted mite, *Tetranychus sexmaculatus* is not as common as the purple mite. However, when heavy infestations develop, there is a heavy leaf drop of the new foliage. The same preventative spray schedule used for purple mites has also offered an effective control for the six-spotted mite. It has been rare that a six-spotted-mite infestation would occur in the spring in those groves which received a dormant spray containing either lime-sulfur, DN, or an oil emulsion. In one particular experiment in 1935, part of a grove was sprayed with a dormant copper-oil spray. There the six-spotted-mite infestation was checked with very little damage to foliage. However, in the unsprayed portion of the grove, a heavy leaf drop resulted from mite injury. There has not been a general infestation of six-spotted mites for six or seven years, and the probable reason is that a large percentage of the groves have received a dormant spray containing either lime-sulfur, DN, or an oil emulsion. In the spring of 1946 several heavy infestations of six-spotted mites were reported and in each case no fall or winter spray had been applied.

Since the rust mite, *Phyllocoptes oleivorus*, is almost always present, it is just as practical to use preventive sprays for its control as for either purple or six-spotted mites. Many growers have been reluctant to spray or dust trees with sulfur when no fruit was on them. As reported by Thompson (2) in 1939, and Camp (1), in 1943, it was found that when both a dormant and post bloom spray containing

<sup>1</sup>DN—a 40% material of 2,4-Dinitro-o-cyclohexylphenol.

sulfur were applied, the rust-mite population was reduced to a very low level. Then the follow-up summer oil spray was able to check the already low mite population to such an extent that further rust-mite control measures were unnecessary until late summer, or in some sections until the winter months. In the Vero Beach area, where a dormant and a post-bloom copper-wettable sulfur spray were applied for the control of scab, melanose, and rust mites, and where these were followed by a summer oil spray, further treatments for rust mite were not required until December. In the Ridge section a somewhat similar program has been used except that zinc replaced copper in the dormant spray. Such a program has maintained low rust mite infestations until July and sometimes until September or October. In general, the dormant sulfur is not an extra spray since the omission of either the dormant or the post-bloom sulfur treatment has invariably necessitated a sulfur application before the summer oil spray. Another reason for the dormant sulfur application is to prevent early rust mite injury on fruit. While it is quite possible that a sulfur spray may not be necessary after August to October on early varieties which are to be picked by December 1, it should be noted that a period of 5 to 8 months elapses between the last sulfur spray in the fall and the time for the post-bloom spray. During that period a very dense population of rust mites usually develops on the leaves and young twigs, and if for some reason the post-bloom spray is delayed, the mites will injure the young fruit. The delay of the post-bloom sprays is sometimes required due to the fact that the spray crews may be needed to handle the irrigation equipment during the dry periods which are common during the spring months. Where dormant sulfur applications have been used, rust-mite control has been effective until May or later. This affords the grower a wider margin of time in which to apply the post-bloom spray.

There have been indications that a heavy rust-mite infestation on the leaves and twigs of the summer and fall growth may be a contributing factor in causing mesophyll collapse

during the winter months. Mesophyll collapse has been observed on the tops of trees which were heavily infested with rust mites, but free of purple mites or purple-mite injury. It is realized that mesophyll collapse does occur on some trees where neither purple mites or rust mites are present. However, in some groves where there have been spotted infestations of rust mites, those trees which were free of mites showed no mesophyll collapse or leaf drop.

The schedule of the fall and/or dormant sprays plus the post-bloom spray is by no means infallible, but during the past 3 to 4 years it has been practiced successfully by a number of production managers who supervise thousands of acres of citrus. At times certain spray applications have not controlled the mites satisfactorily. Although it is not always possible to trace the cause of failure, the lack of thorough coverage is the most common fault. In spite of the fact that thorough coverage is of prime importance for the success of any spray program, many operators are very careless in the application of materials for mite control. It should be understood that purple mites and rust mites infest both the upper and lower surfaces of the leaves, as well as the fruit and young twigs, but that six-spotted mites infest only the under surfaces of the leaves. It must be remembered that purple mites and rust mites are usually most abundant on the tops of the trees during the cool months of the year. Furthermore, all of the materials used to control mites are contact insecticides. Therefore, both surfaces of the leaves should be as completely covered as is economically possible. Sulfur may be a possible exception since it appears to have some fumigation effect against rust mites in warm weather. However, there can be little, if any, fumigation effect during the winter and early spring months when the weather is cool and often windy. Since contact is essential for satisfactory control, the success of any schedule depends upon the coverage of the foliage with the insecticide. It has been observed that some grove operators have the mechanical sprayers moving at a much faster rate when sulfur or sulfur-DN sprays are applied than when an oil emulsion is used.

If a sufficient amount of material is expected to be deposited on the under surfaces of all leaves, on the tops of the trees, along the sides of the trees not adjacent to the sprayer, and on inside leaves, the rate of the sprayer must be slow enough that there is sufficient air turbulence to turn the leaves. A rate of 1.5 to 1.7 miles per hour is as fast as a sprayer should be driven regardless of the type of head in use. A more thorough coverage was obtained with a Speed Sprayer equipped with a double head and driven slowly than with one equipped with a single head, but driven at a faster rate. The writer had an occasion to inspect the coverage where a neutral copper-wettable sulfur-DN spray was being applied with a Speed Sprayer using a single head. It was evident that the Speed Sprayer was being driven too fast, and when some of the leaves were collected from the top of a tree and examined, it was found that only a trace of the material was on the upper surfaces of the leaves and none on the under surfaces. These leaves were heavily infested with rust mites and some purple mites were present. This was true in spite of the fact that it had been less than four weeks since the dormant zinc sulfate-wettable sulfur-DN spray had been applied. Thus, poor coverage in that grove had resulted in a heavy infestation of rust mites on the tops of the trees even after two sulfur applications within a period of less than four weeks. In comparison, only an occasional rust mite and very few purple mites were found in another grove three months after the dormant spray which was applied with a Speed Sprayer equipped with a double head, but driven at approximately 1.7 miles per hour.

The coverage obtained with pressure sprayers has been as variable as with the mechanical sprayers where the proper direction of the spray crews has been neglected. The brushing type of application where just the outside of the trees is sprayed is the common method of applying all materials except oil emulsions. On trees over 15 feet in height with rather dense foliage the brushing type of spray has not been as effective as where the spray was driven up through the inside of the trees. For in-

stance, in one grove where there was a heavy infestation of rust mites some trees received a thorough brushing spray of copper-wettable sulfur. Other trees received, in addition to the brushing spray, a fast inside spray where the spray gun was operated under the trees for no more than 10 to 15 seconds. Three days after the application, an examination of the leaves was made for the presence of rust mites. On trees receiving the brushing spray only 4 percent of the outside leaves were found to have live mites on them, but 30 percent of the leaves on the inside of the canopy and 40 percent near the trunks were infested. As opposed to this, on trees receiving the brushing spray plus the fast inside coverage, no infested leaves were found either on the outside or on leaves on the inside of the canopy. However, 3 percent of the leaves near the trunks were still infested. In general, more failures to obtain control have been traced to lack of coverage than to any other cause.

Weather conditions are sometimes responsible for uncertain results. Rain within one to three days after a DN spray appears to reduce the effectiveness of the treatment. The use of improper mixtures or improper combinations of materials have been the cause of unsatisfactory mite control. Thompson (3) has reported that where a ratio of 2 to 1 of zinc sulfate to hydrated lime is used in combination with DN, that the control is not as satisfactory as with a ratio of 3 parts of zinc sulfate to 1 of lime. DN is sometimes combined with lime-sulfur. This usually results in poor control when too much lime-sulfur is used, as the high pH of the lime-sulfur adversely affects the toxicity of the DN. A dense population of mites at the time of application is also a factor in the length of the period of control. Generally, where there is a heavy infestation of either purple mites or rust mites at the time the insecticide is applied, reinfestation is more rapid than where there is a light infestation at the time of application. One of the reasons for preventative sprays, aside from preventing injury to the trees from either mites or sprays,

is to obtain control for the longest possible period with a single operation.

Where effective control of purple mites has been accomplished during the dormant season, it has not been necessary to use control measures after the flush of new growth. Injury to young foliage and fruit has been observed in commercial groves as well as in the experimental plots where DN was applied on young

1945 the average maximum temperature was 91° between April 24 and April 30. Although oil emulsion and copper-oil emulsion sprays have been found safe to spray on young foliage, young fruit sometimes may be injured. In 1944, 14 to 20 percent of the fruit was marked on trees sprayed on April 6, April 20, and May 19. However, in 1945, where the same type of spray was applied during both March

**SOME SAMPLE SCHEDULES FOR THE PREVENTION OF HEAVY INFESTATIONS OF PURPLE MITES, SIX-SPOTTED MITES AND RUST MITES DURING THE FALL, WINTER AND SPRING MONTHS**

Periods for Applications	Wettable sulfur 10 lbs. * DN 10 ozs. or 1% DN — sulfur dust	Wettable sulfur 10 lbs. * DN 10 ozs. or 1% DN — sulfur dust	Wettable sulfur 10 lbs. * DN 10 ozs. or 1% DN — sulfur dust	Oil emulsion 1.3% oil * (Do not use oil spray if weather is dry or cold)
Oct. 15 to Jan. 1				
Jan. 1 to Flush of growth	Zinc sulfate 3 lbs. Hydrated lime 1 lb. Wettable sulfur 10 lbs. DN 10 ozs.	Wettable sulfur 10 lbs. DN 10 ozs. or 1% DN — sulfur dust	Neutral copper 2 to 3 lbs. Zinc sulfate 3 lbs. Manganese sulfate 3 lbs. Hydrated lime 1½ lbs. Wettable sulfur 10 lbs. DN 10 ozs.	Zinc sulfate 3 lbs. Hydrated lime 1 lb. Wettable sulfur 10 lbs. DN 10 ozs.
Post-bloom Starting 2 weeks after petal fall.	Neutral copper 2 to 3 lbs. Wettable sulfur 10 lbs.	Neutral copper 2 to 3 lbs. Zinc sulfate 3 lbs. Hydrated lime 1 lb. Wettable sulfur 10 lbs.	Neutral copper 2 to 3 lbs. Wettable sulfur 10 lbs.	Neutral copper 2 to 3 lbs. Wettable sulfur 10 lbs.

\*Amounts of Materials are on a 100-gallon basis.

Obtain the Spray Schedule of the Better Fruit Program for the complete seasonal schedule.

foliage and on fruit where the temperature was above 89°. In 1945, no marked fruit was observed in plots sprayed March 24, April 4, and April 15 with a neutral copper-Dn-wettable sulfur spray, but some fruit was marked in plots sprayed April 24. Normally this would be a period in the year when the maximum temperature would not exceed 88°, but in

and April, practically no marked fruit was observed. However, a copper-oil spray applied on July 17 for melanose control on late-bloom fruit marked the early bloom fruit of Hamlins, Pineapples, and Valencias on the same trees where there were only traces of injury to the small late-bloom fruit. No injury was observed in adjacent plots where the copper was omit-

ted in the oil spray. It should be noted that as there was no flocculation of the copper or separation of the oil, the materials appeared to be compatible. Seasonal variations of temperature and type of growth are factors limiting the safe use of most materials on the market for purple-mite control. The danger of injuring young foliage and fruit during the post-bloom period is an additional reason for mite control during the dormant season. If it is necessary to treat for purple mites when young foliage is present, and it is not practical to use an oil spray, a 1 percent DN-sulfur dust may be used with a fair degree of safety. It has been demonstrated that a DN-sulfur dust causes much less injury to young foliage than a DN-wettable sulfur spray. However, care should be taken not to apply excessive amounts of the material to any one part of a tree.

In conclusion, the use of sprays to control mites during the fall and winter months is recommended in order to prevent heavy infestations from occurring in the spring when considerable injury might result. If the treatments are made during the dormant season, there is little or no danger that the materials used in

the sprays would damage either the fruit or foliage. If it is necessary to control purple mites when young foliage is present, either an oil spray or a DN-sulfur dust may be used.

The following schedules can be used as a guide for the combined control of mites during the fall and winter months. The schedules are the same as recommended in the Better Fruit Program but they are arranged without the alternates except where DN-sulfur dust can be substituted for a DN-wettable sulfur spray. For the complete seasonal program the Spray Schedule of the Better Fruit Program should be consulted.

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## PROGRESS REPORT ON CHEMICAL WEED KILLERS

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During the past year a new type of active ingredient for herbicidal sprays was introduced by several commercial concerns. This material is the organic compound 2,4-dichlorophenoxyacetic acid, now generally abbreviated to 2,4-D. Herbicides containing 2,4-D seem to have fewer objectionable features than those containing such materials as the arsenicals, sodium chlorate, and the more recently introduced dinitro compounds. They are reported to be non-poisonous to animal life at herbicidal con-

centrations. They do not create a fire hazard as does sodium chlorate. The roots of perennial species are more effectively destroyed. When properly applied the subsequent germination of seeds in the soil of treated areas is not inhibited to so great a degree nor for a prolonged period. The 2,4-D herbicides are cheaper.

This compound belongs to the group of growth-regulating substances known as plant hormones. Work with these compounds on plants has been directed primarily towards increased usefulness by stimulating the rooting of cuttings and transplants, stimulating the setting of fruit, preventing the premature drop-



ping of fruit, and developing fruits which were seedless. For the desired effects in these respects the growth-regulating substances have been applied as very dilute solutions, about 20 to 40 p.p.m. For several years, however, it has been known that considerably greater concentrations of some of these hormones killed many species and varieties of plants. Death did not result from a caustic action on the foliage nor a poisoning or toxicity, in the ordinary sense, to cell substance. Evidently certain unfavorable growth responses were induced which eventually resulted in death. Plant physiologists have been in disagreement as to the actual cause of death, since the exact functions of plant hormones and hormone-like substances in plants are, as yet, imperfectly understood. Regardless of the manner of killing, these new materials seem to offer unique possibilities for a selective herbicide, since a great number of noxious broad-leaved species were killed by a spray which affected but few of the grasses. Among the most potent of these compounds was 2,4-D at concentrations from about 500 to 1500 p.p.m. in the spray solution. Up to the present time a satisfactory kill (90%) has been reported for it on 125 to 150 different species, partially satisfactory on about 50 more, with some 60 species, including many grasses, reported as being resistant.

Different species responded in different ways to treatment with 2,4-D. Most susceptible broad-leaved species, however, reacted rather violently and in a more or less typical manner. This was not a quick dying of above-ground parts as with conventional weed-killers. Within a few hours after treatment in warm weather there was a curling or bending (nastic movements) of the leaf blades, petioles, and tender stems. In a few days the leaves become chlorotic. Within about a week the leaves were dead and the stems dying, often splitting longitudinally. By this time the underground parts had commenced to swell and split. In about 2 or 3 weeks the roots became soft and soon died. The few grasses affected were mostly in the seedling stage. This signified the selective nature of 2,4-D as a herbicide.

The first interest in 2,4-D at the Citrus Experiment Station was because of the possibilities it seemed to offer in the control of the balsam-apple vine (*Momordica charantia* L.) in citrus groves. Most citrus growers are well acquainted with this pest, particularly those in the warmer areas on fairly heavy moist soil. In these warmer areas this vine is a perennial thing, but usually makes little growth during the drier winter months. During the rainy season, however, on good soil it often covers the surface with a mat of vines a foot or more thick. Unless controlled in such areas the vines may entirely cover large citrus trees within a period of 3 or 4 weeks. This shades the tree severely and results in reduction of both quantity and quality of fruit. Trees thus shaded for 2 or 3 months become sparse of foliage and take on somewhat the appearance of a declining tree.

Frequent mowing, combined with hoeing and hand pulling of vines from under and out of the trees where the mower cannot reach, has been the conventional method of control. This is expensive, especially when considerable hand work is involved. New tops sprout from roots left in the soil, and although a vine may be severed from the main root at the crown it may survive because of roots which may have formed at any node along the stem in contact with the soil. The balsam apple seeds prolifically and the seeds have a high germination percentage.

Last year the first trials on the control of balsam vine with 2,4-D sprays were made. The pure chemical, which is not water-soluble, was used. It was dissolved first in warmed and melted Carbowax 1500 (polyethylene glycol) which served as the carrier. This mixture was soluble in water. The concentrations used were 500 and 1000 p.p.m. actual 2,4-D (7 oz. 2,4-D in 2 lbs Carbowax/100 gal. water and 14 oz. 2,4-D in 4 lbs. Carbowax/100 gal. water respectively). Spraying was done with a knapsack sprayer. The foliage was sprayed sufficiently to wet without excess drip. The weather was warm and soil moisture fair. These conditions prevailed for at least two months after

the sprays were applied. The spraying was done at Lake Alfred, Winter Haven, Port Mayaca, and Davie. In some cases only the vines under the tree were sprayed. In others vines up to and including those on the lower branches were sprayed, while in still others the entire tree with vines in it was sprayed. Both orange and grapefruit trees were included and ranged in size from young non-bearing to bearing trees about ten feet high. Thus not only was the response of balsam vine but also the response of citrus to 2,4-D tested. In addition a few 3/4" diameter sweet orange seedlings free of vines were sprayed and another lot of the same seedlings was irrigated with 1 gallon per tree of 1000 p.p.m. solution of 2,4-D.

The tops of sprayed balsam vines responded in the same manner and at about equal rate to both 500 and 1000 p.p.m. sprays. Within a day after spraying the leaf blades and petioles were badly curled. By the second day a faint chlorosis was apparent in the leaves and by the fourth day the chlorosis was distinct in all leaves, with some starting to die. After about 5 or 6 day the stems started to split longitudinally and became brown. The tops were completely dead within about ten days and with the 1000 p.p.m. spray a foot or so of the main root had become soft, split and was decaying. In two weeks as much of the root system as could be conveniently traced was dead or dying on those plants receiving the 1000 p.p.m. solution. Cuttings made from these roots failed to sprout when placed in moist soil in a shady location. The roots of the 500 p.p.m. sprayed plants took between 4 and 5 weeks to reach this same stage. Incidental to these tests it was found that morning glory (*Pharbitis spp.*) was more easily killed than balsam vine, probably because of the greater density of foliage which caused a greater absorption of 2,4-D. Spanish-needle (*Bidens spp.*), poke-weed (*Phytolacca rigida* Small and *P. americana* L.), elder (*Sambucus Simpsonii* Rehder.), and a number of other species were also found to be susceptible.

A week or so after the tops of balsam vines on some of the plots had died a number of

balsam seedlings emerged. It was not definitely known whether these were from soil which had received a direct application of 2,4-D or not. At any rate, they were sprayed with 2,4-D at 500 p.p.m. when they were about 8 inches high. This caused curvature of the leaves and petioles without killing many seedlings. Several weeks after considerable top had grown, the same strength solution gave a satisfactory kill. Evidently the very young seedlings did not have enough foliage to absorb a lethal amount of the spray.

The effects of 2,4-D on citrus observed from these preliminary trials appeared to be at least partially dependent upon the size of the tree as well as the actual amount of 2,4-D applied. The young sweet orange seedlings sprayed with 1000 p.p.m. solution and those irrigated with this same solution showed a yellowing and curling of leaves and tender shoots within 6 weeks. Shoots started dying back in about 2 months and at the end of 4 months the seedlings in both cases were completely dead. Those sprayed with 500 p.p.m. solution responded more slowly and were less severely affected. On these there was a yellowing and curling of foliage and young shoots, followed by the loss of many leaves and the killing back a foot or so of shoots. Several months later they seemed to have partly recovered for they appeared to be growing almost normally. In no other instances were deleterious effects noted on citrus, regardless of tree size, unless the spray solution came in contact with the foliage. When only a few leaves on the lower branches were sprayed the first response noted was a mottled chlorosis which appeared in about 1 month. This was followed by a slight stiffening or thickening of the leaf blade. Within about 2 or 3 months a splitting and corking of the midrib and most of the primary lateral veins occurred on the upper surface of many leaves. When entire branches or trees were sprayed these same leaf symptoms appeared as well as a distortion of new growth, even though the new growth did not appear until some time after the spray was applied. The most serious damage noted on bearing or near-bearing cit-

trees was the killing back of some young tender growth a foot or more. All these deleterious effects decreased in severity with an increase in tree size, or with a decrease in the actual amount of 2,4-D applied. No difference in varietal susceptibility was noted at this time, except in one case where rough lemon root stock shoots were more severely damaged by 1000 p.p.m. spray than was the young shoot growth on the sweet orange top.

The inhibiting effect of 2,4-D on seed germination was also tested. Sunflower seeds (*Helianthus annuus*) were planted in flats containing 3 different soils: a sand, a sandy loam, and a sandy peaty muck. The original irrigation, which was to saturation, was made on one series with a 1000 p.p.m. solution of 2,4-D. On the control series it was with tap water. Thereafter tap water was used on both series. Germination in the 2,4-D treated soil averaged about 3% of that in the controls. The inhibiting effect on germination was least in the sandy peaty muck and about equal in the other two soils. Germination in the treated soils from subsequent plantings did not approach that in the control series for about 10 weeks during which 11 irrigations to near saturation with tap water were made.

The next trials with 2,4-D were made about the middle of November on a commercial scale in two orange groves on sandy peaty muck soil in the Davie area. The spraying was done on a warm day and the temperatures ranged from warm to cool for several weeks afterward. There was good soil moisture. No rain fell on any plot for at least 20 hours after spraying. The plots included a total of about 11 acres sprayed, plus suitable control plots. A power sprayer was used in the application of the sprays.

One set of plots consisted of six acres of a 5-year old Navel orange grove. The spray was applied at 75-100 pounds gauge pressure through two double Boyce guns fitted with No. 3 discs. Half these trees were sprayed with 500 p.p.m. and the other half with 1000 p.p.m. 2,4-D solution, made up as before with Carbowax. The growth of balsam vines in this

grove was what might be termed medium. By spot spraying, covering all the balsam vines up to the lower branches, a satisfactory coverage was secured with approximately 100 gallons of spray solution per acre. Little spray drift was obtained at this pressure. In these plots 4 trees, badly covered with vines, were selected for spraying the entire trees. This was done primarily to test the susceptibility of the variety to 2,4-D. Each tree was thoroughly wet, two with 500 p.p.m. and two with 1000 p.p.m. solution.

Another set of plots was laid out in the same 5-year old grove and sprayed in an identical manner except that 2,4,5 trichlorophenoxyacetic acid was used instead of 2,4-D. There were reports that the 2,4,5-T had, with a few species, given a better kill than 2,4-D. The method of formulating and the concentrations used were the same as before. The trees receiving 2,4,5-T at 500 p.p.m. were Valencias and those receiving 1000 p.p.m. were Navels.

A third set of plots was laid out on an acre of a 15-year old Valencia grove badly infested with balsam vines to a depth of about 1 foot over a considerable portion of the area. Many trees were rather heavily loaded with vines. The spray pressure here was increased to 300 pounds and two 6-nozzle broom guns fitted with No. 4 discs were used. Spraying was done as rapidly as the spray hands could walk and sweep the vines with spray up as far as the lower branches. Half the trees were sprayed with 500 p.p.m. and the other half with 1000 p.p.m. 2,4-D. The tops of two trees covered with vines were completely sprayed, one with the 1000 p.p.m. solution and the other with 500 p.p.m. Slightly over 200 gallons of spray solution were used on this acre. Spray drifted a row or so from the point of application at the pressure used here.

Frequent inspection of these plots was not convenient. When they were visited 3 days after spraying the response of balsam vine appeared to be about the same for the two different strengths of both 2,4-D and 2,4,5-T. Perhaps curling and chlorosis of the leaves was slightly farther advanced in the last grove

where more solution was applied at the higher pressure. At this time it was also observed that young succulent elder sprouts were badly curled and that the "needles" of Brazilian-oak (*Casuarina lepidophloia*) root-suckers along the windbreaks where spray had been applied were becoming chlorotic. At the end of a month the tops and most of the roots of practically all the balsam vines in all plots were dead, so far as could be determined, except in those cases where the vine tops were in trees above the level to which spray was applied. Almost as important as the kill of balsam in some restricted sections of these groves was the kill of elder sprouts. Young succulent canes had apparently been killed completely unless they had originated from large old roots. The large woody canes were killed back a couple of feet, but later sprouted new tops. Old roots with tender tops were killed back a foot or so from the crown. New tops later developed on some of these. Less regeneration of elder occurred at the higher spray concentration. *Casuarina* suckers about 1/8" to 1/4" in diameter were killed back to the mother root. Larger ones were completely defoliated and killed back to a point on the stem about 1/4" in diameter.

At the time the second inspection was made no very marked effects from the sprays were apparent on the citrus trees. Those trees which had been completely covered with spray were slightly chlorotic and there was some distortion of new growth. By mid-January many of the leaves on the lower branches which had been sprayed and most leaves on those sprayed completely, particularly the 5-year old Navels, were showing the characteristic mottled chlorosis with the splitting and corking of midribs and veins mentioned earlier. Sporadic flushes of growth were appearing with an upward curling of the new leaves where spray had been applied directly to the foliage of young trees. The older trees were showing these same symptoms but to a lesser degree. At this time there appeared to be no difference in the response of citrus to 2,4-D and 2,4,5-T when applied at equal concentrations. After about

three months there had been a considerable loss of leaves and some small branches had died back on the 5-year old trees where foliage was sprayed. New twig growth and leaves were continuing to curl in some instances. The curled leaves evidently were ideal for the establishment of aphid colonies, as many were still further curled by these insects. At this stage the most severe damage to citrus apparently resulted on the 5-year old Navels from 2,4,5-T at 1000 p.p.m. and the next most severe from 2,4-D at 1000 p.p.m. The Navels and young Valencias sprayed with 500 p.p.m. 2,4,5-T and 2,4-D were only slightly damaged. No severe leaf-shedding, or shoot-killing was observed in the 15-year old Valencias as a result of the 2,4-D sprays. In no case was there evidence of damage to citrus except where the sprays had come in contact with foliage. Generally where either of these sprays at either concentration was applied to citrus foliage, bloom appeared earlier on the sprayed portions than on the unsprayed portions of the same tree or on adjoining unsprayed trees. The sprayed trees or portions of trees also made shoot growth slightly earlier and continued with scattered bloom and growth flushes at least until May, when the last inspection was made. Some bloom even occurred on the distorted young flushes. Little fruit set on any of this scattered bloom, and before making appreciable growth it became malformed, turned yellow and was shed, or sometimes dried and remained on the tree. Frequently on Navels, the fruit stems and calyxes would remain green and enlarge after the fruits had been shed. Fruit shedding was much more severe with Navels than with Valencias. Fruits which did set on sprayed portions of Navel trees often became ovate, obovate, pyriform, flattened, or otherwise misshapen. These malformed fruits were coarse and rough with the pistil usually persistent and frequently enlarged. With the exception of the persistent pistils, malformations were relatively scarce with Valencias, and the coarseness or roughness was slight. All the foliar symptoms of unfavorable growth responses lessened with each succeeding flush

and by May some flushes were practically normal in appearance.

The results of all tests thus far had indicated there was no practical reason for using these compounds at strengths greater than 500 p.p.m. of the actual acid for the control of the balsam vine and several undesirable weed species found in citrus groves. Furthermore, there was some evidence that less damage resulted on citrus at the lower concentration, as indicated particularly by the response of the 5-year old Navels. It was also obvious that the spray should be confined to the weed species around and under the trees. As little spray as possible should come in contact with citrus foliage. Although there was no clear-cut evidence from these trials that damage was done to citrus by spray drift, there are such reports from California. Very young trees might be seriously damaged in this manner. As pointed out earlier, damage to citrus appears to be somewhat in proportion to the size of the tree as well as the actual amount of the acid coming in contact with the foliage, and perhaps with the growing roots.

There was no evidence that 2,4,5-T offered any advantage over 2,4-D in weed eradication. On the other hand, it appeared to be somewhat more injurious to citrus. Since it is a much more expensive material and more difficult to secure than 2,4-D, its use in this field is not justified. No further trials with it were made.

In late April, at the time of the last inspection of the plots at Davie, grass and weeds were beginning to grow on many of the areas where balsam vine had shaded out all other growth previously. Balsam vines were coming back, apparently mostly from seed, rather abundantly in many of the sprayed plots. Little or no difference could be seen in the amount of balsam regeneration as a result of the various treatments. In some instances this regeneration was about as severe as on adjoining mowed areas except that there were fewer vines in the trees where the sprays were used. From this it was evident that a series of treatments would be necessary for satisfactory control of this vine.

This presents several questions which can

only be answered by further investigation before qualified recommendations can be made for or against the use of 2,4-D sprays in citrus groves. Will 2,4-D accumulate in our citrus soils in amounts sufficient to damage citrus roots more than would cultivating for the same degree of control? If so, will the number of applications required for satisfactory weed control be sufficient for such an accumulation? Can 2,4-D be absorbed by undamaged roots and transported to the tops where damage might result? Can it be applied readily and yet avoid a harmful amount of spray drift? Do different varieties have different degrees of susceptibility? Will it be more harmful to desirable cover-crop species than the good derived would warrant? Is it definitely not harmful to animals and humans? Then if the answers to these are favorable; when, how, in what formulation, at what concentration, and under what conditions can it be best applied? Will it be more economical than the conventional methods of weed control?

We have partial answers to some of these questions and can speculate somewhat intelligently on the others. If sprayed under conditions of good soil moisture and with the amount now indicated as necessary for weed control, it seems improbable that accumulation of 2,4-D in the soil would become great enough to damage plants. To illustrate; take a hypothetical case on a light sandy soil. From 1.5 to 2.0 pounds of actual 2,4-D per acre per application should be sufficient for controlling a very heavy weed growth. If properly sprayed, most of this would be retained on the weed foliage and would break down into its harmless constituents before it reached the soil. Assume, however, for the sake of argument that it did all reach the soil in its active state. Assume also that it was all carried into the surface 6 inches of soil and no further by a light rain. Assume further that this material remains in the active state until the soil has dried down to the wilting point. In a sand under these extreme conditions, the concentration might be about 75-100 p.p.m. in the soil solution. If any roots survived in this dry

soil they might be damaged by the 2,4-D or absorb enough of it to damage tissues elsewhere in the plant. The sweet orange seedlings irrigated with a 2,4-D solution gave some evidence that it was transported from the roots to the tops where damage was done. If all the 2,4-D concentrated in the surface inch or so where the soil moisture was likely below the wilting point the concentration would be greater. But there would likely be no roots surviving at this moisture content to be damaged or absorb 2,4-D for transport elsewhere. In a sand with fair soil moisture the concentration would be reduced to a fraction of the above figures. In the heavier soils the concentration would be even lower. Under certain extreme conditions with very sensitive plants, however, some damage might result if concentrations considerably lower than we now have reason to suspect are deleterious.

Any great accumulation of 2,4-D in the soil under Florida conditions would be prevented by leaching and its breakdown in the soil. Spraying in groves at low pressures, 75-100 pounds, and using a spray nozzle on the order of the Bean bordeaux nozzle with the aperture reduced to 1/16 inch, which throws a flat fan-shaped stream instead of the conical stream of the conventional citrus gun, would prevent serious misting. These precautions would aid in confining the spray to the species to be killed. This would be particularly important around young trees or varieties displaying a relatively high degree of susceptibility such as lemons and Navel oranges apparently have. If vines had grown into the trees they should be pulled so the tops could be sprayed on the ground, or cut them and let new tops grow before spraying. Spray as soon as sufficient top has grown to absorb a lethal amount of 2,4-D and before they are in the lower branches to any extent or have started producing seeds. Cover-crop grasses are affected little if at all by the concentration of 2,4-D that would be necessary. Time the spraying so as to permit other desirable cover crop species to seed and thus regenerate themselves naturally. Spraying for water-hyacinth (*Piaropus crassipes* Brit-

ton) control gave no indications that fish were killed or cattle grazing on the sprayed plants harmed by 2,4-D. New compounds and proprietary mixtures of 2,4-D are constantly coming on the market. Prices have not yet been fully established or stabilized but most of these will be cheaper, and all of them are more easily made up, than the sprays used in the foregoing tests. The several newer compounds and mixtures tested thus far by the Citrus Station have all been about equally effective at a given concentration and in the absence of rain for 8 or 10 hours following application. Although conditions vary widely, one might now predict that perhaps 3 applications, judiciously applied, at an average cost of about \$6.00 per acre per application for material, labor, and equipment would give practical control of the balsam vine in rather heavily infested groves for a period of several years.

We have underway at the present time additional tests on a commercial scale with several of these newer materials. From these we hope, within the course of a year or so, to determine the ultimate effects of 2,4-D on citrus and desirable weed species, as well as the best formulations with respect to stickers and spreaders for various species. By then we should also be able to tell about its cultural and economic feasibility and to make specific recommendations for or against its use in citrus groves. In the meantime, regardless of the promise it now seems to offer, it is to be recommended in citrus groves only in an experimental way, and then with a full knowledge of its possible damaging effects.

On first thought water-hyacinth eradication may seem a little far afield from citrus culture. The irrigation and/or drainage, however, of citrus groves in many sections is dependent upon lakes, canals, and streams so badly infested with hyacinths so as to seriously impair their usefulness in these respects. Moreover, these sources of water supply and drainage are gradually filling with decayed vegetation from the hyacinths. The advantages of an economical eradication method for hyacinths

is so obvious that it needs no discussion. Thousands of dollars have been spent in Florida in the past for this purpose without securing any practical relief. Accordingly we initiated a series of tests last year on the feasibility of such a program with 2,4-D.

The spray mixture applied in these treatments and the concentrations of actual 2,4-D at which each was used were as follows: (1) Manufacturers formulation of methyl ester of 2,4-D @ 500 and 1000 p.p.m., (2) Manufacturers formulation of butyl ester of 2,4-D @ 500 and 1000 p.p.m., (3) 2,4-D in Carbowax formulated as in previous tests @ 500 and 1000 p.p.m., (4) Manufacturers formulation of alkanolamine salts of 2,4-D @ 500 and 1000 p.p.m., (5) the sodium salt of 2,4-D @ 500 and 1000 p.p.m., plus B1956 @ 4 oz./100 gal. as spreader, (6) The ammonium salt of 2,4-D @ 500 and 1000 p.p.m., plus B1956 @ 4 oz./100 gal. as spreader, (7) The sodium salt of 2,4-D @ 1000 p.p.m., plus bentonite @ 2 lbs./100 gal. as sticker, (8) The ammonium salt of 2,4-D @ 1000 p.p.m., plus bentonite @ 2 lbs./100 gal. as sticker, (9) The sodium salt of 2,4-D @ 1000 p.p.m., plus 1/2 gal. lubricating oil and 1/4 oz. B1956/100 gal. as sticker and spreader, (10) The ammonium salt of 2,4-D @ 250 and 1000 p.p.m., plus 1/2 gal. lubricating oil and 1/4 oz. B1956/100 gal. as sticker and spreader, (11) The sodium salt of 2,4-D @ 1000 p.p.m., and (12) The ammonium salt of 2,4-D @ 1000 p.p.m.

With the exception of a few preliminary tests with a knapsack sprayer all hyacinth treatments were applied with a power sprayer, using conventional grove equipment and relatively high pressures.

The various treatments were all about equally effective for a given concentration of 2,4-D on hyacinths in a comparable physiological condition and under the same temperature conditions. No rain fell on any of the treatments within 48 hours after application. A good kill was obtained on young tender plants just coming into bloom when sprayed in hot weather

with both 500 and 1000 p.p.m. 2,4-D in Carbowax. The kill was estimated at 95% complete in one week with the 1000 p.p.m. solution, with about two weeks for the same kill at 500 p.p.m. When this same mixture was applied at 1000 p.p.m. on large hardened plants in cool to cold weather an estimated kill of 95% was obtained within about 5 weeks. The 500 p.p.m. solution was not tried in cold weather. Subsequent trials were made in warm weather with the other spray combinations mentioned above on hyacinths ranging in size from young tender plants to large ones about two feet tall. The results of these trials indicate that under the average temperature conditions prevailing in central and southern Florida during the spring, summer, and fall, a satisfactory (95%) kill should be obtained on any hyacinths in about 2 or 3 weeks following proper application of 2,4-D at concentrations from 500 to 1000 p.p.m. Some lag should reasonably be expected with the weaker solutions and probably a slightly poorer kill with a little more regeneration, especially under certain extreme conditions which will be discussed later.

The first conspicuous response of hyacinths to lethal amounts of 2,4-D is a downward bending of the petiole. This occurs within a day or so after spraying. It is soon followed by a chlorosis and brownish discoloration of many leaves. Within about a week the central axis is decaying and this is soon followed by a deterioration of the root system. The entire plant finally disintegrates and sinks. Frequently the enlarged petioles will remain a discolored green and afloat for some time after the remainder of the plant has disappeared. This was observed most frequently where the weaker solutions were used.

The absence of rain immediately following any of these treatments gave no opportunity to distinguish between the efficiency of the various spray mixtures because of the sticker and spreader used with respect to retention of potency following rain. To get a rough

idea of the relative efficiency of those with sticking and spreading agents as compared to those without these agents when rain followed soon after application, some of the plots were sprayed with water as soon as the spray had dried. Sufficient water was sprayed with a power sprayer on these hyacinths receiving "rain" to be the estimated equivalent in washing effects of a fairly heavy rain. The treatments thus washed were 1000 p.p.m. 2,4-D from sodium salt plus oil and B1956, 1000 p.p.m. 2,4-D from sodium salt, 250 and 1000 p.p.m. 2,4-D from ammonium salt plus oil and B 1956, and 250 and 1000 p.p.m. 2,4-D from ammonium salt. Adjacent to these were suitable control plots sprayed with the same combinations and concentrations of sprays but not washed with water.

As was more or less expected, the rate of effectiveness of all these sprays was reduced somewhat by the "rain." The kill was satisfactory on each of the 1000 p.p.m. controls within 15 days, with a lag of a few days for plants sprayed with 1000 p.p.m. plus a sticker and spreader, and then washed. Where plants were sprayed with 1000 p.p.m. solution but without a sticker or spreader and then washed, at least the rate if not the ultimate effectiveness was noticeably reduced. When the last inspection was made at the end of 20 days it was estimated that 90 to 95% were dead or apparently dying, but the absolute final kill could not be definitely determined at that time. The final results on the 250 p.p.m. plots were also questionable at the end of 20 days. Probably about half the plants in the controls were dead with many more evidently damaged beyond definite recovery.

The plants of this series sprayed with 2,4-D plus a sticker and spreader and then washed were in a somewhat better condition than the corresponding control. However, most of them were distorted and considerably discolored. Perhaps one-half were dead or badly damaged. Those sprayed at 250 p.p.m. without a sticker and spreader and then washed were distorted, but most of the plants remained green. It did

not seem probable that the final kill with these would exceed 30%.<sup>1</sup>

While these tests clearly showed that the water-hyacinth could readily be killed with reasonable amounts of 2,4-D, the economic feasibility of eradication by this method remains to be established. The plant is reproduced by seed and by shoots. Reproduction by seed would not appear to be an important factor, inasmuch as it is thought that probably a very small percentage germinate. The seed, however may lie dormant for several years before germination. This might necessitate some spraying over a prolonged period for complete eradication. Rhizome shoots, which break off from the parent plant, are the principal means of regeneration. These shoots at first may sink to the bottom. In a short time the petioles become inflated with air and are sufficiently buoyant to float the young plants. It would seem that one or two clean-up sprays after the initial application would take care of these shoots and any other plants missed previously.

A satisfactory method of applying the spray on lakes and hard-to-get-at places in canals and streams remains yet to be found. It is primarily on this and the regeneration factor that the feasibility of a hyacinth eradication program now rests. The solution will probably have to be reached by some trial and error methods. There are several such movements underway in the state now.

The use of aircraft for either spraying or dusting 2,4-D on hyacinths is frequently suggested. Such trials have been made and an unsatisfactory kill for dusts reported. The

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<sup>1</sup> Two months after these tests with "rain" on 2,4-D sprayed hyacinths were made the kill was approximately 95% or better on all plots except the two sprayed with 250 p.p.m. solution and then washed. On these the kill was about 75% complete where a sticker and a spreader were used and about 50% complete where they were not used. Under both circumstances there were many distorted plants regenerating new roots above the old damaged root system. New roots were found arising both from the central axis and from the petioles within an inch or so of their bases.



likelihood of getting drift from spray or dust to cultivated areas adjacent to the treated area may also be an objectionable feature to this method of application, but there are some reports to the contrary with sprays. At least in uncultivated areas application from the air seems to have promise. Aerosols of 2,4-D might be employed in such places.

Occasionally the question arises as to the damage that might result to cultivated crops if irrigated or sprayed with water from a body where 2,4-D had been applied to hyacinths. The risk for irrigation appears negligible. Irrigation intakes are placed 3 or 4 feet below the surface to prevent sucking air. Thus before reaching the irrigated crop even a heavy application of 2,4-D would be diluted to a fraction of a part per million. In the soil it would be further diluted by the water already present before irrigation started. The risk from spraying appears to be somewhat greater. Frequently the intakes for automatic tank fillers are barely submerged. If 2,4-D had very recently been sprayed or dusted in liberal amounts in the immediate vicinity of the intake, its concentration in the spray water might be dangerously high.

Para grass (*Panicum purpurascens*. Raddi) is another serious pest in some groves and along some canal banks. Although 2,4-D sprays have been reported as ineffective for the control of such species, a series of Para grass plots were sprayed at Davie about five weeks ago. Three different formulations of 2,4-D, which included the carriers it was thought might be most effective, were used on grass about 3 ft. tall. These were each applied at 1000, 2000 and 4000 p.p.m. Within 4 days the leaf blades had become chlorotic on the plots at 2000 and 4000 p.p.m. That sprayed at 1000 p.p.m. was little affected. The next inspection was made a day or so ago. The above ground parts of some of the very young shoots receiving spray at 2000 and 4000 p.p.m. were dead but the older shoots were making new terminal growth. All roots appeared to be living, unharmed. Some slight leaf-blade chlo-

rosis was the extent of damage from the weakest solutions.

Wild caladiums (*Caladium spp.*) sometimes obstruct the flow in drainage ditches of hammock groves on the East Coast. They are difficult to control by mowing, regenerating new tops rapidly from fleshy roots and rhizomes. Excellent control was secured within about 10 days with 2,4-D at 1000 p.p.m. from the ammonium salt in one test near Vero Beach. Caladium leaves were found hard to wet, but the desired results were obtained by the addition of 3/4 gallon of oil emulsion per 100 gallons and misting the spray on through a No. 3 disc at about 75 pounds pressure.

All of our tests thus far with 2,4-D seemed to signify that the damage done to a susceptible species was approximately directly related to the amount of 2,4-D retained on the foliage in proportion to the size of the stem and extent of the root system. Plants such as balsamvine and water-hyacinth, which usually have relatively large leaf areas as compared to stem and root volume, were readily killed with fairly light applications of 500 p.p.m. solution. Poison ivy (*Toxicodendron radicans* L.), large elder, and casuarina suckers having little leaf surface as compared to stem and underground parts were only severely checked by the same spray. Thus the use of the lower concentrations in sufficient quantities to lightly but completely cover the leaf surface seems indicated for species with abundant foliage and relatively little stem and roots. Less solution at higher concentrations would appear to be better for eradication of species with little foliage and large stems and roots. Another factor involved here is the amount of spray retained and/or taken in by leaves of various species because of the nature of the cutinization and placement of stomata. More investigation on suitable stickers, spreaders, and penetrants for various species may be needed before the water soluble salts of 2,4-D can be used in all cases with the highest degree of efficiency obtainable with them.

For those who wish to experiment with these herbicides; there are now 15 or more

manufacturers of 2,4-D weedkillers. The products come in both liquid and powder forms. The liquid range forms range from about 10% to 40% 2,4-D, depending on the manufacturer. They are in a carrier which acts as sticker and spreader or have these added. Some of the powder forms carrying around 60% 2,4-D also contain sticking and spreading agents. The water-soluble sodium salt contains 70% and the water-soluble ammonium salt 83.5% 2,4-D. Neither of these salts contain stickers or spreaders. The liquid formulations are generally more expensive to use. In some cases the concentrated solution has sold for \$10.00 to \$12.00 per gallon. The powder forms are relatively cheap, ranging from about \$2.00 to \$3.00 per pound. The total cost of materials would be increased slightly over these latter figures for those containing no sticker or spreader if such agents were necessary on the particular species to be sprayed.

Although the Citrus Station is not yet recommending 2,4-D sprays in citrus groves or other cultivated areas, there may be some who will wish to try them in such places. If so, certain precautions should be followed, at least until it is learned more fully what to expect from these sprays. Use the lowest dilution of 2,4-D with which it is possible to get the desired results. Spraying should be done when there is good soil moisture. Not only

would this reduce the possibility of damaging concentrations in the soil, but a better kill of weeds would likely be secured because of their more succulent growth under such conditions. Keep the spray stream and mist away from those plants on which damage is objectionable. Be extremely careful in this respect around nurseries or young trees. Do not drain a spray tank containing 2,4-D solution in the grove or near plants it is not desired to kill. After using 2,4-D always follow the manufacturers directions regarding the cleaning of spray equipment. Cleaning should be done immediately after use. Under no circumstances should other types of spraying be done without first having thoroughly cleaned the equipment. From California it has been reported that damage to lemon trees resulted from residual 2,4-D in the equipment after washing and flushing twice with clean water and putting out two or three subsequent tanks of oil spray. For the oil-soluble compounds it is generally recommended that the equipment be washed either with kerosene or an emulsifiable oil in water. Soap, sal-soda, or trisodium phosphate at about 1 pound to 25 gallons of water are recommended for cleaning after the water-soluble compounds have been used. Be sure to clean the pump, strainer, hose and guns also. Letting the tank stand full of clean water overnight should be desirable, particularly with wooden tanks.

# VEGETABLE SECTION

DR. J. R. BECKENBACH

## THE PRODUCTION OF TOMATO AND CELERY PLANTS IN SEED-BEDS AS AFFECTED BY METHOD OF IRRIGATION, FERTILIZATION AND SOIL STERILIZATION. I. PLANT RESPONSE

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The Vegetable Crops Laboratory probably gets as many calls from growers because of troubles developing in seed-beds as are received for any other phase of crop production. With the exception of trouble caused by disease or insect difficulties, causes for seed-bed failures have been hard to interpret. A large proportion of such calls seem to be based on complex nutritional difficulties.

It became possible last year to give this complex of problems some concentrated attention. A rather complicated series of experiments was planned in order to (1) develop, under controlled conditions, seed-bed disorders, comparable to those observed in the area, and (2) produce, also under controlled conditions, satisfactory seed-beds.

It was felt that several factors required study, and as many as possible were included in the test. Those included were:

1. Two different soil types (Leon fine sand and Manatee fine sandy loam).
2. Two methods of irrigation (Overhead

sprinkler and seepage around the beds).

3. Three herbicide treatments for weed and possibly disease control (Uramon applications, chlorpicrin, and a check).
4. Three planting dates, in order to measure the time that should elapse after the herbicide treatments (One, two & three months).
5. Two nitrogen sources (All mineral nitrogen vs. all-organic nitrogen).
6. Four rates of fertilizer application (1000, 2000, 4000 and 8000 lbs. per acre of bed).
7. Two different type crops (Tomatoes, in the seed-bed a short time only; and celery, in the seed-bed for a longer period).

Perhaps a further explanation is required relative to the fertilizer applications. A 4-9-3 formula, which is pretty much standard for the area, was used throughout.

In the mineral nitrogen mixture,  $\frac{3}{4}$  of the nitrogen came from sulphate of ammonia, with  $\frac{1}{4}$  from nitrate of soda. In the organic nitrogen mixture, equal portions were obtained from castor pomace, soybean meal, packing-house tankage, processed tankage, and Chicago sewer sludge.

In order to eliminate possible trace element

disorders, 1 lb. of manganese sulphate, 1/2 lb. of zinc sulphate and 1/2 lb. of borax were added to each 100 lbs. of fertilizer.

### RESULTS

At this writing, it is too early to make very many over-all recommendations as a result of this test. There were, however, a few results which stood out and which should be of real value to those who grow plants in seed-beds on sandy soils for setting to the field.

Most outstanding were the comparisons of the two irrigation methods. Almost without exception, and regardless of the other factors, overhead irrigation produced more and better tomato and celery plants than did seep irrigation. Germination was better and more uniform, and the growth of the seedlings was generally superior.

It was obvious that seep irrigation, when the beds were heavily fertilized, reduced germination sharply in the centers of the beds. No such "burning" resulted from daily overhead irrigation.

It was also obvious that continued seepage leached out the fertilizer along the edges of the beds. Plants (especially celery) remained dwarfed and yellowish. Probably side-dressings would have reduced this damage, but none were applied in this test.

The heavier soil (Manatee fine sandy loam) was superior to the lighter sand (Leon fine sand) in producing celery plants, but both soils produced excellent tomato plants. Since

the best celery plants on the Leon sand were produced at the highest fertility level and with all-organic nitrogen, it is probable that side-dressings would have greatly improved the plants on this soil. All mineral nitrogen was as satisfactory as all-organic nitrogen on the heavier soil.

Differences were not significant among the herbicide treatments from the standpoint of plants produced. However, both Uramon and Chlorpicrin acted as weed controls, although they were effective, generally, on different weeds. Uramon, supplying nitrogen as well as acting as a herbicide, showed benefits in plant growth from the nitrogen in some cases. The standard application used (1 lb. per sq. yd.) was too high on the Leon soil, however, making the soil extremely difficult to wet, and burning plants, either directly or indirectly. Chlorpicrin was considered to be more desirable than Uramon for general use for this reason.

Further discussion should probably be postponed until the experiments have been repeated a few times. The only test so far has been on winter seed-beds. It is possible that summer or fall seedbeds might give somewhat different results. We do feel that many of the difficulties experienced with seed-beds could be overcome by substituting overhead irrigation for seep irrigation as much as possible. The superior results should more than compensate for the expense of installation of an overhead system.

# 2,4-D FOR THE CONTROL OF NUT GRASS

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The control of nut grass *Cyperus rotundus* L. is a problem that has received the attention of a great many workers. Fields have been abandoned because the dense stands of nut grass have increased production costs to a point where it was no longer profitable to grow a crop on the land. In 1938 (6) Smith and Mayton reported that "plowing or disking at intervals of three weeks or less during two consecutive growing seasons" had given

is laborious and fairly expensive. Since then 2,4-dichlorophenoxyacetic acid or 2,4-D as it is more commonly known has been discovered as an excellent herbicide for many plants. (2, 3, 4 and 5). Because of the unusual amount of interest that was shown by these early experiments small tests were made at the Vegetable Crops Laboratory to see what effect 2,4-D<sup>1</sup> would have on nut grass.

In the first experiment young nut grass plants growing in flats in the greenhouse were sprayed on Dec. 18, 1944 with enough material to thoroughly wet the foliage. The 2,4-D was used at .1% and .2%. No effect on the growth of the nut grass was noticed for about a week. The sprayed plants then started to turn a pale

TABLE I—EFFECT OF 2,4-DICHLOROPHENOXYACETIC ACID ON NUT GRASS

Treatment	Flat	Number of Plants				
		Dead	1 green leaf	2 or more green leaves	No Injury	Total
.1% 2,4-D	1	96	5	0	0	101
	2	103	5	4	0	112
	3	90	4	2	0	96
	4	70	5	2	0	75
.2% 2,4-D	1	114	7	2	0	123
	2	188	5	2	0	195
	3	131	2	0	0	133
	4	92	2	2	0	96
Check	1	0	0	0	176	176
	2	0	0	0	90	90
	3	0	0	0	127	127

effective control of nut grass. This is an expensive method and compels the laying aside of the areas for two seasons. More recently Fromm (1) has reported some success in the elimination of nut grass from the soil by the addition of 1 liter of 2N calcium thiocyanate solution to 1 square meter of soil. This method

to a yellowish green and stopped growing. The decline of the sprayed plants was gradual but became progressively more severe until on

<sup>1</sup> The 2,4-D was furnished by the Dow Chemical Co., Midland, Mich., and the E. I. duPont de Nemours and Co., Wilmington, Del.

Jan. 2, 1945, many of the plants were dead. The unsprayed plants continued to grow rapidly and have a thrifty green appearance. The final results were taken on January 10, 1945, and are presented in Table 1. All of the sprayed plants probably would have died if the tests had been carried longer.

The second experiment was conducted in the field during the fall of 1945 on almost a pure stand of nut grass. The 2,4-D used at the rate of 1 lb. of a 70 percent wettable to 100 gallons of water, was applied with a knapsack sprayer on October 17 on replicated plots in comparison with Ammate (ammonium sulfamate). The nut grass was in a thrifty condition with an occasional flower stalk in evidence. The growth was so dense that it required heavy applications of the spray materials to get thorough coverage.

The general reaction of the nut grass to 2,4-D was the same as in the greenhouse test. No effect was noticeable for several days, but after about a week the plots sprayed with 2,4-D started to turn yellowish green. As the days passed they became more yellowish, finally turning brown and dying. On Nov. 8 most of the nut grass plants sprayed with 2,4-D were dead, a few had 2-3 yellowish green leaves, but even these plants finally died. At no time was there any twisting or distortion of the plants, a symptom which is so characteristic of 2,4-D on most other plants. The effect of 2,4-D on nut grass is illustrated in figure 1. The picture was taken on Nov. 19 and is typical of the check and 2,4-D sprayed plots.

The Ammate sprayed plots responded similarly to the 2,4-D plots. The leaves first turned yellowish green, then yellowish brown and finally died. However the kill with the Ammate was not quite as complete as with the 2,4-D. Nut grass plants that had started to produce flower stalks were slow in responding to both 2,4-D and Ammate, but even these in most cases failed to flower.

#### EFFECT OF 2,4-D AND AMMATE ON NUT GRASS TUBERS

Even though 2,4-D and Ammate will kill

the tops of nut grass plants, the question that naturally arose was, will they also kill the tubers? This point was determined by digging and selecting 50 of the best new tubers from each treatment. Some difficulty was experienced in collecting these tubers from the 2,4-D and Ammate plots since most of them had started to disintegrate. These tubers were planted on Nov. 29 in flats in the greenhouse for germination tests. The results were taken on Jan. 3 and are presented in Table 2.

A further check on this point was made by digging and selecting 25 additional apparently sound tubers from each replication and planting them in flats in the greenhouse on Dec. 6. The final germination counts were made on Jan. 3. The results are presented in Table 2.

A third test was conducted in which 100 old tubers (they had all produced at least one plant) were dug and then planted in flats in the greenhouse to see if the herbicide was translocated from the tops to the old tubers in sufficient quantities to kill the tubers. This was done on Nov. 15. The final results which are presented in Table 2 do not give a complete picture of what happened. The tubers from the check plots started growing immediately and had all germinated within a few days and produced vigorous plants. Many of the tubers that did germinate from the 2,4-D and Ammate sprayed plots were very slow in germinating. A few did not germinate until 5 weeks after planting.

The data for this test clearly illustrates that 2,4-D may kill better than 99% of the new tubers found and furthermore will also destroy some of the old parent tubers. Ammate will also do this to some extent but is not as effective as 2,4-D.

The next question that arose in this test was how soon after treatment can the soil be used without danger of injury to commercial crops. To answer this question soil from the top 2 inches of the 2,4-D plots was thoroughly mixed along with the dead nut grass tops and placed in pots in the greenhouse. A similar series of pots were filled with soil from the



Fig. 1. The effect of 2,4-D on Nut grass (4) unsprayed plot (1) sprayed once with 2,4-D

check plots. The samples were taken on November 9, 23 days after the nut grass had been sprayed. Tomato seedlings were set in these pots to see if there was any residual effect of the 2,4-D.

Seedlings that were set immediately in the 2,4-D soil were killed within a few days. Tomato seedlings that were set in the same soil 11 days later lived but were severely stunted. Another series of tomato seedlings was set in this soil on Dec. 19 which was 64 days after the nutgrass had been sprayed. There was no evidence of injury in any of the tomato plants.

In another test 2,4-D was sprayed on to soil at about the same rate as used in the nut

TABLE 2—EFFECT OF 2,4-D AND AMMATE ON NUT GRASS TUBERS<sup>1</sup>

Treatment	Number of Tubers Producing Plants		
	Test 1 <sup>2</sup>	Test 2 <sup>2</sup>	Test 3 <sup>2</sup>
2,4-D	3	2	45
Ammate	14	24	68
Check	44	60	100

<sup>1</sup> Tubers were dug and then planted in flats of steamed soil in greenhouse.

<sup>2</sup> Test 1—50 apparently sound new tubers were used

Test 2—75 apparently sound new tubers were used.

Test 3—100 old tubers were used.

grass test. The soil was thoroughly mixed and placed in pots in the greenhouse. Three types of soil were used: Manatee fine sandy loam heavy phase, Manatee fine sandy loam light phase, and Leon fine sand. Injury to tomato seedlings occurred in all soil types after 35 days but not after 60 days. The injury appeared to disappear more rapidly from the light Leon sandy soil than from the Manatee heavy. The Manatee light was intermediate.

## CONCLUSIONS

The data presented indicates that 2,4-D as a spray offers promise as a herbicide for the elimination of nutgrass from cultivated fields. One application at 1 lb. of a 70% wettable material to 100 gallons of water gave complete kill of the tops and better than 99 percent of the new tubers were destroyed. There was also a reduction in the viability and vitality of the old parent tubers but not a complete kill. The numbers of applications of 2, 4-D that will be necessary to completely eliminate all the nutgrass from an area still has to be worked out.

There is some residual effect of 2,4-D in the soil, so susceptible crops should not be planted soon after treatment. Tomatoes have been severely injured in some tests even 35 days after treatment. No injury to tomatoes has been observed after 60 days but this may happen under some conditions.

Ammate also has shown some promise as an herbicide for nut grass.

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# HYBRID SWEETCORN PLUS OIL TREATMENT – A GOOD COMBINATION FOR EARWORM CONTROL

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## INTRODUCTION

Within the past few years considerable interest in sweetcorn has been noted. Jamison (1) estimates that more than 1000 acres of sweetcorn were grown in Florida in 1945. He also states that 3 varieties — Golden Cross Bantam, Ioana and Illinois Golden No. 10 produced the principal part of the crop.

## FUTURE OUTLOOK

The writer has grown sweetcorn for 4 years in Florida strictly from an entomologist's viewpoint. There are always "worms" present in corn, the 2 principal ones being the corn earworm *Heliothis armigera* Hbn. and the fall armyworm *Laphygma frugiperda* S. & A. Both of these occur as budworm and as earworms. These can be effectively controlled. It is important to have a good hybrid sweetcorn grown as a vegetable, because it matures quickly and at an even rate, thus reducing treatment and harvesting costs besides greatly reducing insect attacks. Two pickings should suffice for a well grown hybrid field. A slow growing, uneven-silking corn is not an economical crop to grow for the reason just given. Probably an important reason for a tall hybrid is the fact that laborers do not like to bend their backs and low bushy corn is hard to oil.

Florida is ideally suited for growing sweetcorn for the northern market. Any sweetcorn planted from January on through March will find a ready market. It requires careful timing

of the corn crop to harvest it for the holiday trade if grown in the fall.

## CULTURAL PRACTICES

A grower may produce 14,520 stalks of corn when it is planted 1 foot apart in the row and 3 feet between the row, or 10,890 plants per acre if he uses 4 feet between rows and the same spacing in the row. Calculated on the basis of 1 marketable ear per plant it is possible to harvest 1210 dozen of ears from the 14520 stalks or 908 dozens from the 10,890 plants per acre.

To raise corn like this it is necessary to treat it as a vegetable and supply water and fertilizer. The usual procedure in the Manatee section is to apply a 4-5-7 fertilizer at the rate of 1000 pounds per acre at the time the ground is bedded and prepared for seeding. All corn is grown on beds to allow for irrigation and for drainage. Another side dressing of 1000 pounds per acre is usually given when the corn is at the height where it has 13 leaves. It is obvious that varieties of corn vary according to the season, so height is no criterion. Some growers apply 100 pounds of nitrate of soda when the corn starts to produce shoots.

It is important that corn receives moisture to insure a good germination and produce sturdy plants. Watering afterwards is according to the needs of the plant, emphasis being placed upon a good watering when the corn is silking. To grow corn profitably and as a vegetable, it must be fed and watered so that its growth never lags.

Baiting is considered by the writer as a cultural practice because it is necessary to bait to insure a profitable stand. Corn is a favorite food plant of cutworm. The ideal way is to prebait the field before the corn is planted. If

this is not practical, bait when the corn starts to break through the ground. A bran-cryolite bait made up at the rate of 1 part of cryolite to 9 parts of bran is applied at the rate of 30 to 40 pounds per acre. Some growers prefer to use molasses and water with the bait thus making a wet bait. The writer uses a dry bait. The advantage of a dry bait is that there is no waste of bait and it can be applied from a plane. The above mentioned bait is harmless if it falls upon the plants.

#### VARIETIES

Many varieties have been tested under Florida conditions and the 3 mentioned in this paper have shown the most promise not only for adaptability, but for yield and response to ear treatments. Screening tests are being conducted in various parts of the state to find varieties that are even better than these three varieties.

#### INSECTICIDE TREATMENT OF THE EARS

So far no corn has been grown in the Manatee section that has entirely withstood the attacks of earworms. It is true that several varieties have a fair degree of resistance but to insure a clean ear it is necessary to treat the ear with insecticides. The writer has used a heavy mineral oil (380 Saybolt) and 0.2% pyrethrum preparation which is injected at the dosage of 1/4 teaspoonful or 1/2 cc of oil into the tip of the ear when the silk has wilted. The pyrethrum had been extracted in a kerosene type oil. The oil is injected by means of a pump oiler similar to that used by mechanics. It is necessary to wait until the silk wilts because pollination has then taken place and a fully developed ear will be the result. All ears should be treated. The top ear matures earlier so it silks before the lower ears. This frequently necessitates 2 oilings. Oiling too early or when the silk is green results in a misshapened ear. Oiling too late or after the silk has browned may fail to kill the worm because it has progressed too far into the ear. The effect of ear treatment on Golden Cross Bantam is given in Table 1.

This paper has dealt with the oil injection

TABLE 1—THE EFFECT OF EAR TREATMENT ON GOLDEN CROSS BANTAM SWEETCORN

	Sept. 1942			Jan. 1943			Feb. 1943			March 1943			Feb. 9, 1944			Feb. 23, 1944		
	Total Ears	Total Worm	% Free Ears	Total Ears	Total Worm	% Free Ears	Total Ears	Total Worm	% Free Ears	Total Ears	Total Worm	% Free Ears	Total Ears	Total Worm	% Free Ears	Total Ears	Total Worm	% Free Ears
Mineral Oil	76	47	61.8	52	41	78.8	64	47	73.4	86	60	69.8	108	93	86.1	91	72	79.1
Mineral Oil + Dichloroethyl Ether	78	53	67.9	76	57	75.0							124	109	87.9	91	73	80.2
Mineral Oil + Pyrethrum							60	30	50.0			29.3						
Clipping																		
Check	84	41	48.8	61	0	0	56	17	30.4	90	11	12.2	64	12	18.8	78	14	17.9

of individual ears which gave a very good control. In more recent tests not reported herein, DDT has been tested as an earworm control. In all of these tests, a partial control has been indicated but in no case have the results been comparable to those of the oil injection method.

Several growers are using a 3% DDT dust on their corn but are going to supplement it with an ear oiling. One grower has a power duster and has given his corn 2 dustings and the 3rd and final dusting will be done by plane. After that he intends to oil the corn with oil and pyrethrum.

#### COST OF INSECTICIDE APPLICATIONS

A final application of 3% DDT dust applied by plane at the rate of 50 pounds per acre costs \$4.725 per acre. Plane dusting costs 4 cents per pound and the prepared 3% DDT

dust costs 5 1/4 cents per pound. This is a higher rate of dust per acre than usually recommended but the grower wanted a good final dusting of the corn.

The cost of the oil and pyrethrum figured on the basis of 1 1/2 gallons per acre costs approximately \$2.37 per acre exclusive of labor. A man can easily oil 10,000 ears in a day.

#### CONCLUSION

Sweetcorn has a definite place in Florida agriculture. The growing of hybrids suited to our climatic conditions plus the insecticidal treatment of the ears should be an inducement for growers to supply the northern demand with good sweetcorn.

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## SWEET CORN VARIETY TRIALS

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Corn is a New World Crop. The early explorers of this continent recorded its importance as a food crop of the natives. Sweet corn however was not mentioned until Sullivan's expedition up the Susquehanna Valley. From that time until the present, sweet corn has been highly esteemed by Americans as a vegetable. The number of varieties has increased and changed from year to year until at present there are hundreds of sweet corn varieties. Many of the varieties are quite similar in the appearance of the ear; the only reason existing for varietal distinction being the season of production, size of stalk or some other plant characteristic. There are varieties, however, which produce eight-rowed ears and varieties producing as many as twenty rows of kernels; vari-

eties producing blue, white, yellow and black kernels; varieties producing long ears or short ears. In fact, there appears to be no limit to the types of ear that seedsmen and others have developed.

Even though the 1940 census reports that Florida produced more than 6,000 acres of sweet corn, it is doubtful if as many as 100 acres were produced. There is an inclination for southern growers to list any corn used for roasting ears as sweet corn. Nothing could be farther from the truth. Sweet corn is a distinct type of corn and requires different culture and handling from field corn.

In Florida varieties of field corn are available that will produce a crop at a lower fertility level and on dryer soil than will sweet corn. That it was believed for years that sweet corn could not be produced in the south may have been in part due to the fact that it was grown as field corn. With the introduction of hybrid sweet corn, the growing of sweet corn was

again tried in many southern areas and even when produced as field corn fair crops were produced. When grown as a vegetable at a higher fertility and moisture level certain of the hybrids were found to be most satisfactory.

The Florida Station recognizing the superiority of sweet corn over field corn as a vegetable has been interested in developing a sweet corn for Florida. Dr. Hull has been testing sweet corn varieties for a number of years. None were satisfactory for crop production when grown in central Florida with the same culture treatment given field corn. Thus, a sweet corn breeding was begun and the probability exists that from this breeding program will come varieties superior to any we now have available.

However, in testing the existing varieties, Dr. Hull found some that were outstanding, Golden Cross Bantam being perhaps the most consistent performer. When this variety was grown on soils of moderate fertility, fertilized liberally and furnished adequate moisture, it responded by producing a stalk half again as high and larger ears. Since then other varieties have been found that produce satisfactory crops. In addition to Golden Cross Bantam, Iona, Illinois Golden No. 10 and Tri State are all acceptable.

Yield, however, is only one factor that must be considered in selecting a sweet corn for Florida. Quality is what sells sweet corn and if the variety does not possess high sugar content, tender pericarp, well shaped ears, kernels of good depth and color, it is definitely lacking and should be discarded for varieties possessing these characteristics. Hybrid corn is well adapted because of the uniformity of ear development; usually one harvesting being sufficient. Other desirable characteristics in a variety are resistance to ear worm damage, a non-suckering stalk and a stalk that will not lodge easily. Another characteristic that apparently varies is the length of time that the ear will remain in the milk or pre-dough stage. This under the high temperature condition usually

prevailing at harvest time would be extremely desirable.

This year the Florida Agr. Experiment Station has 18 promising varieties planted at four locations in the state. Included in this test are four strains of Golden Cross Bantam. In addition to these 18 varieties, another 20 varieties are being grown at Gainesville. Thus, 38 varieties or strains of sweet corn are being tested this year. All are hybrids. In evaluating these varieties for use in Florida, it is essential that something be known of what is wanted in sweet corns. At present it appears that an ear of moderate length—7 to 8 inches long, with 12 to 14 rows of yellow kernels—is desired. The ear should be protected by a tight husk that extends at least 1 inch beyond the end of the ear and this husk should remain a good green in color through harvesting and transit. Thus far, growers have been only slightly interested in season of maturity. Hybrid corn matures uniformly and usually the whole crop can be harvested at one operation. This characteristic is undesirable as well as desirable, in that it reduces the length of the shipping season from any particular field. To extend the season, growers will probably find it advantageous to use several varieties as well as making additional plantings of the same variety. Thus, in the corn variety test time of maturity will be given considerable emphasis.

Methods of worm control are available and no grower should expect to grow sweet corn for shipment without worm control. Thus far the injection of oil into the tip of the ear has been the most satisfactory control, although the use of DDT appears very promising.

Sweet corn deteriorates rapidly after removal from the plant. The deterioration of quality is inhibited by low temperatures. To maintain quality it is essential that the temperature of the ear be lowered immediately after harvesting and held at this temperature until it reaches the consumer. The production of quality corn is of no avail if the corn is not handled properly during the period of preparation for and transit to market. Precooling facilities should

be available to lower the temperature to a maximum of 35° F. and every effort made to hold this temperature during transit.

If Florida growers deliver uniformly high

quality sweet corn to Northern markets, there is a large potential market available; for low quality wormy corn there is virtually no market.

## CHEMICAL CONTROL OF WEEDS ON FARM DITCHES

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Belle Glade

Since we started farming in 1932 we have always tried to keep the ditch banks and levees of our farm as clean of weeds as possible. I well remember in the first few years when we would find a sprig of Jew grass, how we would pull and take it to the house and burn it, to keep it from spreading, for we were aware that it might be infected with mosaic that could be carried to the celery by aphids or other biting insects.

As our land became more used, the weeds multiplied faster than we were able to combat them, especially in the last few years since labor has been so high and scarce. Our loss from mosaic celery has run as high as thirty to forty percent in some fields and the loss in returns has run well into the five figures in one season.

So when information came from various sources about chemical sprays that would kill weeds, we immediately began to learn all we could about them.

When I tell you that on our celery farm of 320 acres we have seven miles of ditches and on our entire acreage we have 35 miles, you will realize why we were so interested.

The weeds on these ditch banks harbor not only the mosaic disease I have spoken of, but also the insects to carry the disease to the celery or other mosaic susceptible crops as well as numbers of other destructive insects to vegetable crops.

The water hyacinths clog up our farm ditches in a few months after being cleaned

with a dragline with hyacinth bucket. These hyacinths, it is claimed, holds back the flow of water as much as 40%, thus not allowing the water to reach our pumps after a heavy rain fall as fast as it should.

This past season, we have had the opportunity to try, in cooperation with the Everglades Experiment Station, a number of the new chemical weed sprays and have found some that work very well, killing the weeds that grow on the banks, as well as the hyacinths. The cost of some of the sprays is still too high, but I believe with the demand for the volume that will be used, these sprays will be materially reduced in cost.

We estimate that to clean both sides of a six to seven foot ditch of a fairly heavy weed growth, would cost, at our present labor scale and inefficiency, about \$100. These weeds should be hauled away, for Jew grass and purslane will not die when uprooted, but will continue to grow and be a menace. This estimate does not include the cleaning of canals of hyacinths with the dragline.

In comparison to hand labor, we now can spray the same mile of ditch with one of the new 2-4-D's of a 40% concentration. We would use about 800 gallons of a solution made up of 1 gallon of the chemical to 225 gallons of water. This will only require two men approximately three hours or a total cost for labor and materials of about \$33.00.

We use our celery spray machine that has a tank that holds 225 gallons of spray mixture. The pressure is held just below 200 pounds. Where the weeds are large or for spraying along our St. Augustine grass covered levees,

we use an orchard nozzle with a large holed disc. One man slowly drives the machine along while the other sits on a platform built beside the spray tank and plays the spray from the nozzle onto the weeds and hyacinths.

On ditches that do not have a heavy growth of weeds, or young weeds which are much easier killed, we use a boom that reaches out to the middle of the ditch and has fish tail nozzles every eight inches. By driving slowly first on one side and then the other, all the weeds and hyacinths receive sufficient chemical to kill them.

We have found that one of the spreaders, commonly used with other sprays, increases the efficiency of the chemical weed spray under our hard water conditions.

We have been able to kill the elderberry bushes and other small bushes that start to grow on our levees as well as the sprout that comes up around the Australian trees we use for windbreaks.

Now that sufficient 2-4-D is available we have started a regular program of weed control. All ditches at our celery farm and around our pastures have recently been sprayed and the weeds and hyacinths are dying—some weeds wilt and die quickly while others take more than

a week, as the chemical must be carried down to the roots, but they all eventually die.

We will spray our ditch banks every 45 to 60 days as needed through the summer months, as we are using a cover crop of Egyptian wheat which is not affected by 2-4-D. In the fall, a few days before we start transplanting our celery into the field, we will thoroughly spray, with a little stronger solution, the ditch banks around the block to be planted—this spraying, according to tests, will keep the ditch banks nearly free from growth for the ninety days that it will take to bring the crop to harvest. Celery and other vegetable crops are so susceptible to the weed sprays that even a fine mist from the spray will seriously damage or kill it, so no spraying can be done around the fields after the crop is once transplanted to the field.

Our levees are covered with St. Augustine grass that is not affected by the weed spray so we can keep weeds far enough away from the celery, that we feel we can cut down a great deal, if not nearly eliminate mosaic from our celery fields. By destroying the hyacinths we will much improve the efficiency of our drainage system. By eliminating weeds, we will also greatly improve the general appearance of our farm.

## INSECTS AFFECTING SWEET POTATOES IN THE EVERGLADES

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The growing of sweet potatoes for the production of starch is a new industry for the Everglades. Prior to 1942, no sweet potatoes, other than small home plantings for food, were grown in this area. At present a considerable acreage is devoted to the production of starch-type sweet potatoes. Expansion of this acre-

age is anticipated. These developments give rise to the question of insect pests of sweet potatoes and their possible significance in this area. Insects are limiting factors in production in many sweet potato growing regions. Thus, it seems desirable to record some preliminary observations made during the past three years on the insects that attack sweet potatoes in the Everglades.

In a general way the period during which these observations were made was characterized by less than normal rainfall. The effect

of this condition on the insects involved is not fully known, but indications are that several species tend to be much more prevalent and injurious during periods of drought. Practically all the observations were made in areas where potatoes were being grown for the first time. Some of the insects will undoubtedly become much more injurious if successive crops of sweet potatoes are grown on the same land. This is true in spite of the fact that the natural factors of control may have a better chance to make their influence felt after the insects have become well established.

The sweet potato weevil, *Cylas formicarius* Fab., is the principal insect pest of sweet potatoes in many areas of the world. Where no control measures are employed, it is capable of complete destruction of the crop. That it will be a factor to be considered in sweet potato production in the Everglades has been amply demonstrated. However certain differences between the procedures involved in production of potatoes for starch and for table use will automatically decrease the chances for weevil injury to the starch potatoes. No storing or curing will be required where potatoes are to be used for starch. Thus there will be no chance for the weevil population to build up after harvesting. Also the presence of one or two weevil larvae in eating potatoes would make them unfit for food, but might not greatly decrease their value for starch production.

The adult sweet potato weevil is about 1/4 inch long. Its head and wing covers are blue-black while the prothorax and legs are bright red. It is rather slender and superficially, resembles a large ant. It has well developed wings and is capable of flight. It is attracted to lights and large numbers are sometimes caught in light traps in the vicinity of heavily infested potato fields. However, as a rule this weevil does not resort to flight and is seldom seen except by those who search for it. In infested fields adult weevils can best be found by examining exposed potatoes at or just below the surface of the soil. They feed on the above ground portions of the plant as well as the exposed potatoes. However, this feeding appears

to be of little significance on starch potatoes. The eggs are deposited in the exposed potatoes and in the stems of the plant. The larvae that hatch from these eggs are dirty white or greyish, legless grubs that attain a length of 1/3 inch. It is this stage that causes the principal damage. They tunnel through the potatoes and stems until full grown. Heavily infested potatoes may be completely destroyed by the feeding of these larvae. Even the presence of one larva may be sufficient to injure the potato and afford a means of entrance for decay or organisms which may cause the potato to rot. The amount of damage caused by the larvae tunneling the stem is often difficult to ascertain. Where the base of the stem is completely tunneled, as is often the case, the yield of potatoes is undoubtedly reduced considerably. The feeding of the larvae in the stems is also often instrumental in reduction of stand. The presence of one larva in the stem of a newly set plant may kill it. When potatoes are not harvested in the Fall, the weevils may kill many of the plants by attacking the new runners in the Spring. In one field a heavy infestation of weevils and a dry Spring caused a loss of more than half the plants.

Many factors that contribute to high incidence of weevil injury remain to be studied. However, variety, type of soil, and moisture relations appear to have considerable influence on the amount of injury caused by weevils. Only a few observations were possible on varietal differences in weevil injury. The most susceptible variety showed 65% infestation of the potatoes at harvest while the least susceptible variety showed only 15% infestation. This difference appeared to be due principally to the fact that in the heavily infested variety a much larger percentage of the potatoes were exposed above the surface of the soil. These figures may be somewhat misleading in that some of the infested potatoes rot and no trace of them is found at harvest time. Potatoes grown on sandy soils seem to be attacked by weevils much worse than those grown on organic soils. The reason for this difference is not known, but might be tied up with moisture relations and

differences in vegetative growth of the plants. Weevils were also observed to be much more prevalent and injurious under dry conditions than they were during wet periods.

Wild host plants of the sweet potato weevil appear to be of no significance in the Everglades proper. *Ipomoea barbigera* Sims, has been recorded as a host plant in Louisiana, but it appears to be very rare in the Everglades. The seaside morning glory, *Ipomoea pes-caprae* (L.) Sweet, is also a host plant and occurs on the coasts but has not been observed growing wild in the interior.

The moonvine, *Calonyction aculeatum* (L.) House, has been recorded as a host but examination of large numbers of this plant growing in the vicinity of heavily infested potato fields has failed to verify this observation. The finding of the larvae of another weevil, *Cryptorhynchus longus* Lec., in the stems of moonvine leads the writer to believe that the earlier records refer to that species. This would be easily possible since the larvae of the two species superficially resemble each other.

Natural enemies of the sweet potato weevil appear to be of little practical importance. No enemies other than ants have been observed to molest the adult weevils. One parasite of the immature stages that has also been recorded by Cockerham (1944) from Louisiana has been recovered in the Everglades. This is *Microbraccon punctatus* Mues. *Neocatolaccus tyloclermac* Ashm. also appeared to be parasitic on *C. formicarius*. The other species that were bred from vines that were infested with both *C. formicarius* and *C. longus* were *Eupelmus cyaniceps* Ashm., *Arthrolaxis* sp., *Heterospilus* sp. and *Euderus* n. sp. Additional work is needed to clarify the status of these insects, but in the observations made thus far none of them were sufficiently abundant to be of any practical value in reducing the population of weevils.

Sweet potato weevil larvae that were killed by fungi were sent to Miss Vera K. Charles, Division of Mycology and Disease Survey, Bureau of Plant Industry, Soils and Agricultural Engineering, Beltsville, Maryland. She was able to isolate a *Fusarium*, apparently *F.*

*solani* App. and Wr. var. *minus* which has been previously recorded from this host. In addition another fungus which appeared to be a species of *Spicaria* was recovered. Although these fungi were more prevalent than the parasites mentioned above the percentage of weevil larvae killed by them was very low.

Another weevil that attacks sweet potatoes in this area is *Cryptorhynchus longus*. The adult is considerably smaller than the sweet potato weevil, being only about 1/8 inch long. It is grayish brown in color with a large, light colored area on the tips of the wing covers and does not at all resemble the adult of the sweet potato weevil. The larvae however, as already mentioned above, are very similar in appearance upon casual examination. Moonvine seems to be the original host in this area and the name moonvine weevil is suggested. Although it attacks sweet potatoes readily there appears little danger that it will become a major pest of this crop. The reason for this view is the fact that the weevils appear to prefer old woody tissue and the larvae have been found in only very old potatoes. They also tunnel through the older stems of the plant and in a few instances have become fairly abundant. A search of the literature failed to reveal any previous record of this insect as a pest of sweet potatoes.

A third species of insect that attacks the underground portions of the potato plant is the wireworm, *Melanotus communis* Gyll. Sometimes the wireworms bore into the potato and tunnel for some distance before emerging again to enter the soil. More often they do not enter the potato, but feed from the outside making shallow irregular holes. Such feeding is chiefly injurious in that these holes thus eaten become the avenues of entrance for decay organisms. If these holes are abundant they may also become filled with soil, making the process of washing the potatoes more difficult. In none of the fields thus far observed has the wireworm population been very great. Thus it is impossible to predict how much damage might be expected where there was a heavy infestation of wireworms.

An aphid has also been found to feed on the



underground portions of the sweet potato plant. Specimens were sent to Dr. Clyde F. Smith, University of North Carolina, Raleigh, North Carolina, for determination. He placed it in the genus *Prociphilis* and stated that it appeared to be an undescribed species. A search of the literature failed to reveal any references to aphids that attack the sweet potato plant below the surface of the soil. This aphid undoubtedly has other hosts than potato, however, since it has been recovered in widely scattered areas where it could scarcely have been carried with the sweet potato plants.

The wingless adults are yellowish in color with a white, stringy, waxy covering dorsally. They feed on all sizes of roots and have occasionally been found on large potatoes. However, they seem to prefer the smaller roots and are usually found most abundantly from 1 to 3 inches below the surface of the soil. This insect seems to be favored by fairly dry soil. Sometimes very heavy infestations of these aphids build up in the late spring. The effect of these aphids on yield was not determined.

During 1945 many large areas of sweet potatoes were completely defoliated by the sweet potato hornworm, *Herse cingulata* Fab. Although this insect had been seen in small numbers in previous years very little defoliation resulted from its feeding. The adult is a large, grayish hawkmoth with pink spots on the sides of the abdomen. The larvæ which attain a length of 4 inches are usually striped and vary in color, but may be distinguished from cutworms by the large size and the "horn" on the dorsum near the posterior end of the body. The pupal period is passed in the soil.

The importance of this insect as a pest of sweet potatoes has not been determined. When hundreds of acres are completely defoliated in a very short time it is very spectacular. However, even when no other food is available the larvæ have not been observed to feed on the buds of the plants although the leaves may be entirely devoured. The sweet potato plant has a remarkable ability to recover from this defoliation and in many instances the plants had put on an entirely new and complete set of

leaves within two weeks. The amount of reduction in yield caused by this defoliation appears to be very slight. In some instances it even appeared that the defoliation might have been beneficial. The leaves were heavily infested with sucking insects and were quite yellow. The new leaves that grew on the plants were a normal green color and the infestation of sucking insects seemed to have been eliminated.

When all the leaves have been stripped from a field the hornworms migrate in large numbers. Where newly established fields are available nearby the hornworms may be capable of causing considerable damage since defoliation of newly set plants would undoubtedly cause the death of many such plants resulting in a poor stand. Fortunately the numerous water control ditches in the area can be made to serve as satisfactory barriers to the migrating worms by seeing that they are not covered with vegetation and that the banks are very nearly vertical.

Natural enemies of the hornworms seem to be of little value. Birds probably consume large numbers when outbreaks occur, but since the larvæ feed at night and underneath the foliage until quite large most of the damage is done before the work of the birds becomes effective. One parasite, *Sturmia inca* Tns., has been reared from hornworms. In none of the fields observed did parasitism become higher than five percent. It appeared that the life cycle of this parasite is not very well synchronized with that of its host. In some of the fields that had been defoliated large numbers of the parasitic flies were present after practically all the hornworms had entered the soil to pupate. In many of these fields another generation of hornworms developed and reached outbreak proportions, but practically all of the parasites had long since died or moved on to other areas.

The southern armyworm, *Prodenia cridinia* Cram., also is capable of completely defoliating fields of sweet potatoes. It often occurs in large numbers in the same fields with the hornworms mentioned above. However it differs from the hornworm in that it has a

large number of host plants other than sweet potato. The methods of feeding, migration and habits of the southern armyworm are very similar to those of the hornworm. During the course of the observations reported herein the southern armyworm has caused extensive defoliation of sweet potatoes much less often than has the hornworm. The natural enemies of the southern armyworm as they occur in potato fields have not been studied.

Another caterpillar that has caused rather severe defoliation of some small plantings of sweet potatoes is the sweet potato leafroller, *Pilocrocis tripunctata* Fab. The greenish caterpillars attain a length of 1 inch. They fold the leaves and tie them together with silk. They are very active when disturbed. Presumably this insect will not become a very serious pest of sweet potatoes since no commercial plantings have been defoliated.

The spotted cucumber beetle, *Diabrotica duodecimpunctata* Fab., and the banded cucumber beetle, *Diabrotica balteata* Lec., often become very abundant in sweet potato fields. However their feeding on well established plantings appears to be of little significance. These insects sometimes occur in considerable numbers in newly set fields. When weather conditions are unfavorable for the establishment of the new plants it seems likely that the feeding of cucumber beetles may be of some importance in reducing the stand. There is also a possibility that the larvæ may become sufficiently abundant in the soil to injure the potatoes. Smith (1923) has described such injury in Louisiana.

Cutworms have on a few occasions caused some damage by cutting off newly set plants. The species most often involved has been the granulate cutworm, *Feltia subterranea* F. Where the land has been properly prepared and no weed growth is allowed to become established this insect should not become an important pest of sweet potatoes.

Several sucking insects attack the above ground portions of the sweet potato plant in this area. Of these, two species have been seen in sufficient numbers to merit further

attention. These are the potato leafhopper, *Empoasca fabae* Harris, and the garden flea-hopper, *Halticus citri* Ashm. Of these the former has been observed in large numbers much more often than the latter. The injury caused by these two species is very similar. Both the adults and the nymphs feed by sucking plant juices from the under side of the leaves. Heavily infested leaves become yellow and eventually die. However, it appears that populations of insects that would prove fatal to many species of plants have little effect upon sweet potato plants. In addition the potato plants are constantly putting out new leaves to take the place of those injured by the insects. There can be little doubt that these insects cause some reduction in yield when they are present in large numbers for long periods. However except in periods of drought the plants seem to do fairly well in spite of the insects. In experimental plots the control of moderately heavy infestations of leafhoppers did not result in significant increases in yield.

No attempt has been made herein to give a complete list of the insects that may attack sweet potatoes in the Everglades area. Quite a few insects, other than those listed, were collected on sweet potatoes during the course of these observations, but they have purposely been omitted because in the opinion of the writer they will be of little or no economic importance. Some of the insects included in this paper may not prove to be so important as pests of sweet potatoes as might at first appear. The exact status of most of them remains to be determined. One of the most remarkable features of the sweet potato plant is its ability to recover from attacks of insects that would be fatal to other less hardy plants. This is indeed fortunate in that sweet potatoes are a long season crop of relative low value per acre and chemical control of all its insect enemies would be too costly.

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# THE DEVELOPMENT OF NEW BEAN VARIETIES FOR FLORIDA

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The breeding of new varieties of beans at the Everglades Station originated with an effort to learn whether any known varieties were resistant to bean rust. Bean fields in south Florida were ravaged by the rust disease in the 1936-37 season, and again the following year. Although it was found that sulphur fungicides would control this disease and powdery mildew, it was considered desirable to determine whether any existing varieties were resistant to bean rust.

During the 1936-37 and 1937-38 seasons tests of a considerable number of varieties of beans were conducted in the greenhouse by inoculating young potted plants with the spores from rusted vines. Bountiful, Black Valentine, Tendergreen and Kentucky Wonder beans proved to be very susceptible. On the other hand a number of new stocks from the Ferry Morse Seed Company were more or less resistant. One stock, 6651, of the Kentucky Wonder type, was practically immune in all the tests conducted in the two years. This bean was only slightly affected by rust in plantings made at six other locations by cooperating pathologists from Florida to Maine. It also was resistant to infection by the powdery mildew fungus when grown in the greenhouse with such very susceptible varieties as Bountiful and Black Valentine.

A cross of the rust and mildew resistant 6651 with the susceptible Bountiful variety was made at the Department of Plant Breeding at Cornell University in 1938. The progeny of this cross were tested and selected through seven or eight generations and a number of very resistant lines of bush snap beans

were developed. None of these however had sufficient quality to be introduced as new varieties, but they have indirectly contributed to the development of one of our new beans as I shall indicate later.

In 1940, we received 47 lots of hybrid bean seed from Dr. B. L. Wade of the U.S.D.A. Vegetable Breeding Laboratory at Charleston, South Carolina. These beans were segregating stocks in the third and fourth generations from several crosses. Single plant selections were made from seven lines in the spring of 1940 when rust and drouth had severely crippled most beans. The next fall five more lines were dropped and only two were carried on by single plant selection. Beginning in 1941 these two lines were increased until it was possible to release stocks to seedsmen in 1943. These new selections were named the Florida Belle and the Florida White Wax. Both were much more resistant to rust than the Bountiful bean. The Florida Belle has been planted extensively in the last two years and has earned a place as a standard variety for the Everglades area, and in north Florida. On the sandy soils in eastern Palm Beach and Broward Counties, the Florida Belle has not always shown the quality of which it is capable under more favorable conditions. The Florida White Wax has not won recognition in this State. We have had reports that it looked good as a canning bean in California.

The Florida Belle was derived from a cross between Stringless Black Valentine and U. S. No. 5 Refugee. Resistance to rust and powdery mildew was obtained by selection in the first and second Florida generations. Tolerance of drouth conditions had been noted in the breeding material before it was released by the Vegetable Breeding Laboratory, and the first selection in Florida was made under drouth conditions. Resistance to common bean mosaic

is inherited from the U. S. No. 5 Refugee bean, one of the parental types.

Florida Belle beans produce large bushes with very strong stems, and a luxuriant foliage. The plants stand erectly, and are moderately branched. The pods are borne well up in the plant and do not become blemished by contact with the soil. The pods are about 7 inches long and narrow and are slightly oval in cross section. It is classed by the trade as a flat bean. The pod color is lighter than Bountiful and Plentiful and does not become shiny or greasy with age. Canneries have expressed a liking for Florida Belle because the pods are not too broad for their clippers and are long and straight. On the fresh market the Florida Belle competes favorably with the Black Valentine. Many growers have found the Florida Belle a more productive bean than other common varieties. Yields of more than 200 hampers per acre at the first picking have been obtained.

While the Florida Belle bean was being developed the trial plantings were in close proximity to the other hybrid lines which we were developing. The segregation of a few seeds with colors not typical of Florida Belle was noted in the fall of 1942 in the sixth generation in Florida. This could only mean that a new cross had occurred naturally, presumably in the fall of 1941. It was assumed that a cross had occurred between Florida Belle and one or more of the disease resistant lines established by crossing Bountiful with Kentucky Wonder 6651. Seed coat colors and plant characters which developed in the progeny of the new hybrids indicated this to be true.

Single plant selections were made from several of the new hybrid lines in 1943, and in each succeeding year until now there are over 100 selections which have been derived from the new hybrid material. These are closely related lines and in the main differ only slightly with respect to plant habit, pod type and

color, flower color and seed color. Several of these lines should be carried on for the purpose of making further selections, particularly with the object of developing resistance to the root rotting fungi prevalent in the east coast sandy soils.

One of the new lines developed from a single plant selection in 1944 has been sufficiently fixed and the seed stock has been increased enough so that it has been released to seedsmen this spring. This new variety has been named the Dixie Belle.

The Dixie Belle is a round podded green bush bean. Its relationship to Florida Belle is indicated by the inclusion of the word Belle in the name. This relationship is clearly seen also in the erect habit of the plant, the very stout stem, and the method of branching at about a 45 degree angle. The pods are about 6 inches long, round, fleshy and stringless. In color they are lighter than Tendergreen. Most of the pods are straight to slightly curved. They are smooth while young, but may show a few creases as in Kentucky Wonder when fully mature. The Dixie Belle plants are large, vigorous, and resistant to several diseases, including rust, mildew, mosaic and root rot; although the term resistance should not be interpreted to mean immunity. In the field plots at Belle Glade this spring these beans have been grown successfully without the use of fungicides. The Dixie Belle promises to be a very productive bean as it blooms profusely and sets a heavy crop of pods.

Specimens of the Florida Belle and Dixie Belle beans have been passed among the audience. It is our opinion that these varieties will shortly dominate all other bean varieties in Florida because of their quality, productivity and resistance to several of the diseases affecting beans in Florida. The development of these varieties stands as testimony to the value of breeding and selecting beans adapted to the conditions and requirements of Florida. The work should be continued not only with beans but with all vegetable crops.

# GROWING AND MARKETING OF SWEET CORN IN THE RUSKIN AREA

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First, to give you a background of raising sweet corn in the Ruskin area, I will tell you our soil type and growing conditions. The soil at Ruskin is a Parkwood fine sandy loam underlain with a "hard-pan" of shell marl about  $2\frac{1}{2}$  feet below the surface of the ground. This "hard-pan" helps hold the moisture up in the root area. Since we have artesian wells, water supply offers us no problem. The land is a sandy loam, therefore the natural fertility is fairly low.

The first planting of this year's corn crop was planted during the latter part of January and successive plantings made until March 13th. Last year's plantings were 129 acres of Golden Cross Bantam. This year's crop is 150 acres of Ioana. These plantings were made immediately following crops of lettuce, cauliflower and tomatoes to use up what fertilizer was left in the ground. The average nitrogen reading at the time of planting was 20 pounds per acre. The corn was planted in rows  $3\frac{1}{2}$  feet apart and 10 rows to the block. The average distance between each plant is about 10 to 12 inches. The seeds were placed just below the ground level in a small trough. Germination was good in all plantings, so we got about 100% live at the beginning.

After the first plantings were getting a good start we had an unexpected  $4\frac{1}{2}$  inch rain along with several other smaller rains. This set the corn back considerably since Ioana likes dry weather. We had no other varieties of corn planted so we were not able to compare Ioana with others in respect to moisture conditions. We do know though that later plantings that did not receive this excess rainfall made much better corn.

Since the nitrogen, phosphate, and potash

content of the soil was fairly good at the time of planting, due to the fact that all of the fertilizer was not used up by the previous crop, our fertilizer program was very simple. The only thing applied to any of the corn was about 125 pounds of nitrate of soda and it was broadcast over the fields and not applied in bands. Some fields of Golden Cross Bantam last year received no additional fertilizer at all and still made a fairly good crop. Frequent cultivation to loosen the soil seemed to do as much good as an application of nitrogen. When the corn was about 18 inches high some fields showed considerable "yellowing" and some stunting after the heavy rains. The yellowed leaves looked very much like zinc deficiency so we tried some nutritional spray test plots. Good results were obtained from an application of 2 pounds zinc, 2 pounds Mg.  $SO_4$ , 4 pounds Mn  $SO_4$ , and 1 pound of lime in combination while an application of each individual compound did no good, and in the case of Mg.  $SO_4$  burned the plant.

As all of you know, about the biggest headache in raising sweet corn is control of corn ear worm. In last year's crop you had to look at a good many ears to find one without worm damage. At the end of May we gave up and let the worms have the rest of the crop. We didn't mind the worm on the silk end so much, it was the one that crawled down the side of the ear and began eating that bothered us. So far this year we have either been lucky or DDT has given us fair control of the corn ear worm so far. We made 5 applications of 2 pounds of 50% DDT per 100 gallon along with a good spreader at the rate of about 100 gallons to the acre. Most of these applications were made after the silks appeared. The spray rig used sprays 10 rows at a time using 40 to 60 nozzles with 350 pound pressure. You can see that a good coverage of the silks was ob-

tained. We haven't noticed any ill effects from the use of the DDT.

Most anyone can grow a crop of corn, but not everyone can harvest, package, refrigerate, and market it correctly. A small farmer just doesn't have the facilities to handle sweet corn after it is harvested so as to retain its sweetness. As you know, sweet corn transforms its sugars to starch in a very short time at high temperatures like we have during the harvest season. According to Appleman and Arthur the loss of sugar in sweet corn is about four times as rapid at 50°F as at 32°F. At 32°F 20% of the initial sugar disappeared through respiration and conversion to starch in four days. The ideal storage temperature is 32°F and humidity of 90% to 98%.

I believe that our method of harvesting and packing is as fast and efficient as I have seen in Florida, although I haven't seen much sweet corn raised. Since we grow the dwarf types of corn, we can drive our harvesting equipment over the tops of the corn stalks without doing any damage. The harvesting carts break down some of the tassels, but it doesn't do any harm then because all of the pollination has already taken place. These carts are pulled by a regular high axle tri-cycle type tractor. The five pickers follow along behind the cart and break the corn. It takes experienced pickers to know the way a mature ear feels and looks. The loaded cart is taken straight to the packing shed in a very few minutes so the corn doesn't have a chance to go through a heat. Since we have had fairly good worm control so far this year we have been packing the corn in bags with out clipping the silk end of the ear. Women grade the corn into ones and twos and place four dozen ears into a green mesh corn bag. When the percentage of worm damage increases we run the corn through a home-made machine that saws off the silk end of the ear and also saws off part of the stem. This aids considerably in grading the corn and also gets

rid of the worm and the undeveloped kernels on the silk end of the ear. This clipping removes much of the garbage from the housewife's kitchen and also saves money and space in shipping. All clippings and cull corn are hauled into pastures and fed to our beef cattle. After the corn is packed into bags it is run through a home-made pre-cooler that drops the temperature of the corn from 85°F down to 40°F in 10 minutes. Straight from the pre-cooler the corn is stacked into refrigerated rooms and kept at a temperature of about 35°F. All of this packaging and cooling is done at a maximum of one hour after the ear is picked from the stalk. Nearly all of the natural sweetness is retained in the corn if it is handled this way. Another important process is the shipping of the corn from the farm to northern markets. The best method we have found so far involves the use of plenty of snow ice. In loading either a railroad car or semi-trailer: first place one layer of corn flat on the floor, then blow a layer of snow ice on top of the corn. Continue this process on every layer until the car is filled. Corn loaded this way arrives in the northern markets "garden-fresh". We are experimenting with some new consumer packages to give the housewife ears of corn that are ready to be cooked just as they are in the package and still are fresh and sweet. The ears are clipped, husked, and cleaned so there is no more work or waste for the consumer. One of the packages contains 3 ears and is the shape of a triangle. The other package we are using, each individual ear is stretch wrapped with a clear film called Plio-film, a Goodyear Rubber product. Large retail outlets like these packages and I think in the future you will see more and more of all types of vegetables sold this way from refrigerated self-service display cases. We have made a few air-shipments of these packages, but the freight on air shipments will have to be lowered some before the average consumer can buy the products.

# THE ASCORBIC ACID CONTENT OF A NUMBER OF VEGETABLES PRODUCED IN SOUTHERN FLORIDA<sup>1</sup>

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During recent years the commercial production of vegetables in Florida has steadily increased until it has become one of the state's major industries. It seems quite probable that this industry will continue to expand as improved methods of cultivation, utilization, and transportation are introduced.

While such factors as yield and appearance have long been used as a basis for the evaluation of our various fruit and vegetable crops, it is only recently that the question of nutritional value has received its just consideration. At the present time considerable attention is being given to the study of the ascorbic acid or Vitamin C content of fruits and vegetables. The purpose of the present investigation is to obtain additional information concerning the ascorbic acid content of a number of the vegetables produced in southern Florida.

## MATERIAL AND METHODS

The vegetables used in this study were obtained during the 1946 season either from lots of Florida-grown vegetables at a local farmer's market or directly from the individual growers themselves. These freshly harvested vegetables were stored in an electric refrigerator at approximately 5°C until analyzed with the exception of the potatoes and a few unripe tomatoes which were stored at room temperature. Unless otherwise designated, this period of storage did not exceed three days.

All of these determinations were made by a colorimetric method previously described in detail by the author (5) except that 3 percent metaphosphoric acid was used for extracting the green peas as recommended by Vavich and his associates (6) instead of the 1 percent metaphosphoric acid described in the above reference. With the exceptions of the leafy vegetables and the few designated in Table 1 as sampled otherwise, each sample consisted either of the whole edible portion of the vegetable or a longitudinal slice removed from the center of this portion.

## RESULTS AND DISCUSSION

In Table 1, the ascorbic acid contents of these Florida-grown vegetables are compared with values obtained from Booher's (2) figures for vegetables produced elsewhere in the United States. The figures from her compilation were chosen as a basis for comparison since they represent values for vegetables grown under a variety of environmental conditions in various sections of the country. Due to the number of different varieties of vegetables produced in the various areas of the United States, it was impossible to compare each of these individual varieties with those produced in Florida. For this reason her figures for mature, edible products were averaged without regard for variety or area in which produced and these averages are presented together with the maximum and minimum values in Table 1. The individual figures used in obtaining these averages are available in her compilation for those who may desire more specific information.

Individual reference to the specific varieties in Table 1 seems unnecessary since most of the vegetables are well known and the data self-explanatory. It seems advisable, however, to include the following information pertaining

<sup>1</sup> This investigation was sponsored by the Science Research Council of the University of Miami.

TABLE 1—ASCORBIC ACID CONTENT OF A NUMBER OF VEGETABLES

Vegetable	Description of Sample	No. of Analyses	Grown in Florida (mg./100 gm.)			Grown elsewhere in U. S. (mg./100 gm.)*	
			Average	Min.	Max.	Average	Range
Bean	Snap					19.2	3.3-45.5
	Bulk Canadian Wonder	5	23.3	20.8-	25.0		
	Canadian Wonder	4	33.2	30.1-	37.0		
	Dutch Caseknife:						
	Whole pod	3	30.4	28.0-	32.2		
	Beans	1	65.6	65.6-	65.6		
	Florida Belle	7	28.4	24.3-	34.7		
	Fordhook Favorite:						
	Whole pod	4	15.6	12.0-	20.0		
	Beans	5	45.4	42.1-	48.7		
	Improved Stringless Greenpod	7	17.0	12.0-	19.7		
	Sensation Refugee	4	22.2	18.6-	25.5		
	Stringless Black Valentine	6	29.9	23.3-	33.8		
	Tendergreen	9	21.8	15.3-	26.2		
	Tendergreen; grown in adjoining plots:						
	sprayed with following:						
	U. S. Rubber 604 "Phygon" plus Zinc						
	and Lime	5	31.1	25.8-	36.5		
	Zinc chromate mixture	5	33.3	29.0-	38.2		
	"Fermate"	5	29.2	23.2-	32.1		
	Copper 8-quinolinolate	5	25.0	20.5-	28.0		
	Sulfur	5	24.6	23.6-	25.1		
	Check	5	25.2	23.0-	26.2		
	Varieties introduced as seed from Columbia; grown in the same plot:						
	Guarzo rayado arbol	4	29.9	27.8-	34.0		
	Estrado arbol	4	29.2	26.2-	32.9		
	Cacao enredadera	2	19.2	17.3-	21.0		
	Radical de enredadera	2	15.6	14.2-	17.0		
	Zardinata de enredadera	2	24.2	21.4-	27.0		
	Comun de enredadera	2	16.8	16.5-	17.1		
	Cargamanto de enredadera	3	22.2	17.2-	24.9		



Vegetable	Description of Sample	No. of Analyses	Grown in Florida (mg./100 gm.)		Grown elsewhere in U. S. (mg./100 gm.)*	
			Average	Range Min. Max.	Average	Range Min. Max.
Bean	Pencil Pod Black Wax	8	20.2	12.1- 27.9	19.9	15.0- 23.6
Wax	Decature	4	43.6	37.0- 49.2		
Pole	Variety unknown	8	22.2	20.0- 27.1		
Broccoli	Buds	8	133.1	126.2-134.4	164.6	135.0-199.0
	Stalks	8	136.3	101.0-167.5	108.5	104.0-113.0
Cabbage	Copenhagen Market	2	59.2	54.0- 64.4	78.9	24.0-180.9
	Charleston Wakefield	1	53.8	53.8- 53.8		
	Globe	2	54.3	53.7- 54.9		
	Resistant Detroit	2	60.1	58.0- 62.2		
	Savoy	2	114.5	112.0-117.0		
	Variety unknown	2	61.2	57.0- 65.3	7.5	5.5- 11.1
Carrot	Nantes	9	18.7	15.3- 24.0	88.3	93.0-103.0
Cauliflower	Super Snowball	2	113.9	110.9-116.8		
	Variety unknown	1	137.4	137.4-137.4		
Celery	Outer stalks	2	13.4	13.2- 13.5		4.3- 7.7
	Inner stalks	2	17.7	14.6- 20.8		6.5- 9.4
	Leaves	2	60.0	48.2- 71.3		14.6- 31.3
Chaya	Jatropha urens L. Leaves	5	465.1	441.6-483.3		
	Tip of branch	1	87.4	87.4- 87.4		
Collards	Variety unknown	6	139.5	116.5-155.8	10.7	10.7- 10.7
Cucumber	Straight-8 Fruit	3	15.8	15.2- 16.3		

Vegetable	Description of Sample	No. of Analyses	Grown in Florida (mg./100 gm.)		Grown elsewhere in U. S. (mg./100 gm.)*	
			Average	Range Min. Max.	Average	Range Min. Max.
Cucumber	Skin	3	26.9	26.1- 27.5		
	Burpee Hybrid	3	18.3	13.5- 21.0		
	Soil grown; fruit	3	24.9	24.1- 26.4		
Dill	Hydroponically grown; fruit					
Egg Plant	Variety unknown	1	75.4	75.4- 75.4	7.1	2.1- 12.1
	Fort Myers Market	1	23.0	23.0- 23.0		
	Variety unknown	3	19.0	18.5- 20.0	13.0	12.0- 14.0
Endive	Variety unknown					
	Outer leaves	1	8.7	8.7- 8.7		
	Inner leaves	1	13.8	13.8- 13.8		
Heckeria	Heckeria sp.: leaves used as a green	4	109.5	95.8-117.0	65.0	65.0- 65.0
Kohlrabi	Variety unknown	4	61.2	55.7- 75.8	12.1	9.0- 20.5
Lettuce	Boston Iceberg					
	Section through head	1	11.4	11.4- 11.4		
	Outer leaves	1	9.1	9.1- 9.1		
	Inner leaves	1	16.3	16.3- 16.3		
Great Lakes	Section through head	4	14.2	10.2- 17.2		
	Outer leaves	2	11.2	10.2- 12.1		
	Inner leaves	2	17.7	15.1- 20.3		
Imperial No. 44	Section through head	2	13.5	11.3- 15.7		
Leaf; variety unknown	Outer leaves	2	34.7	31.6- 37.7	18.1	15.2- 21.0
	Inner leaves	2	18.1	18.0- 18.1		
Murraya	Murraya Koenigii	3	45.1	28.2- 61.2		
	Leaves					

Vegetable	Description of Sample	No. of Analyses	Grown in Florida (mg./100 gm.)		Grown elsewhere in U. S. (mg./100 gm.)*	
			Average	Range Min. Max.	Average	Range Min. Max.
Mustard greens Onions, green	Variety unknown	4	71.9	44.6- 99.8	172.0	165.0-179.0
	Variety unknown Bulbs	6	29.9	25.7- 40.7		
	Tops	1	41.1	41.1- 41.1		
Parsley	Variety unknown	9	243.7	215.0-263.3	161.1	109.4-198.0
Pea	Little Marvel	8	18.1	2.6- 35.7	27.6	16.0-102.3
Pepper Green	California Wonder				121.9	20.1-180.0
	Soil grown	4	190.9	179.7-217.5		
Red ripe	Hydroponically grown	3	136.0	82.5-197.5		
	Ruby King	4	147.1	120.5-179.7		
	Sweet Hot	3	127.9	85.2-164.8	237.5	195.6-281.0
	California Wonder	2	192.3	182.5-202.0		
Potato	Red Bliss (Bliss Triumph)	4	36.1	30.1- 49.1	26.2	25.9- 26.4
	Sebago	4	27.6	26.8- 30.1		
Radish	Tubers collected from a single variety test plot; stored for approximately two weeks before sampled:					
	Bliss Triumph	6	45.0	41.1- 47.1		
	Chippewa	6	25.7	23.3- 27.3		
	Cobbler	6	29.1	21.6- 33.1		
	Pontiac	6	29.0	21.6- 33.1		
	Sebago	6	30.7	21.8- 38.3		
	Sequoia	6	37.5	31.0- 47.1		
	White; variety unknown	4	29.1	27.1- 31.0	26.1	26.1- 26.1

Vegetable	Description of Sample	No. of Analyses	Grown in Florida (mg./100 gm.)		Grown elsewhere in U. S. (mg./100 gm.)*	
			Average	Range Min. Max.	Average	Range Min. Max.
Spinach	Northern	4	67.6	55.0- 79.2	68.3	38.0-113.0
Squash	Yellow Crookneck	9	36.4	26.2- 49.1	12.4	1.5- 23.2
	White Table	3	25.7	24.7- 27.3		
Sweet Potato Greens	Variety unknown	3	140.6	135.8-149.7	23.7	9.8- 72.0
	Talinum triangulare; leaves	4	109.8	93.2-126.2		
Tomato	Cherry	2	51.5	49.0- 54.0	36.4	24.0- 47.1
	Grothen Globe	12	18.1	14.5- 23.5		
Turnip	Soil grown	4	16.7	14.3- 19.8	168.7	121.4-200.5
	Hydroponically grown	4	24.1	17.7- 29.2		
Turnip Greens	Hydroponically grown	4	25.4	21.1- 29.3	36.4	24.0- 47.1
	Picked when pink	5	19.7	17.3- 24.1		
Turnip	Picked when white	11	19.2	15.0- 26.9	168.7	121.4-200.5
	Marglobe	4	43.4	36.8- 50.1		
Turnip	Rutgers	4	40.8	36.9- 44.6		
	Purple Top	3	34.0	29.0- 39.6		
Turnip	White	4	141.6	123.0-172.5		
	Purple Top	3	34.0	29.0- 39.6		
Turnip	Japanese	4	141.6	123.0-172.5		
	Japanese	4	141.6	123.0-172.5		

\* Booher, Lela E., Hartzler, Eva R., and Hewston, Elizabeth M. A compilation of the vitamin values of foods in relation to processing and other variants. U.S.D.A. Cir. 638, 1942.

to a few lesser known vegetables appearing in the table.

The leaves of the chaya tree of Yucatan (*Jatropha urens*) were found to contain an average of 465.1 mg. of ascorbic acid per 100 gms. This is the highest value obtained for any of the vegetables analyzed and is equal to some of the higher values recorded for the guava (*Psidium guajava*) now so widely acclaimed as a source of Vitamin C. Fairchild (3) has described the use of the chaya leaves and branch tips in the preparation of "fritters" which he claims are quite delicious.

The leaves of *Murraya Koenigii*, commonly referred to as Ceylon curry, are highly prized as flavoring material. The bark, leaves, and roots of this tree are used by the natives of India in the preparation of various tonics (1).

At a recent meeting of this organization, Fairchild recommended the more extensive cultivation of *Talinum triangulare* as a summer vegetable in Florida (4). At that time he referred both to its popularity among the inhabitants of the Dutch East Indies as a substitute for purslane and to its high ascorbic acid content as determined by Dr. Curl of the Citrus Products Station. Curl's figure of 160 mg. per 100 gms. is somewhat higher than the 109.8 mg. recorded in Table 1.

It is interesting to note the variation in the ascorbic acid content of the Tendergreen beans treated with the various sprays listed in Table 1. Since these beans were grown in adjoining test plots, it seems reasonable to assume that this variation is due, at least in part, to the spray treatments.

## CONCLUSION

It is evident from the results in Table 1 that vegetables grown under a number of environmental conditions in southern Florida compare favorably in ascorbic acid content with those produced elsewhere in the United States.

## ACKNOWLEDGMENT

The author wishes to acknowledge her indebtedness to the members of the Dade County Co-Operative Market Association, to the Sub-Tropical Experiment Station, and to the various individuals who supplied the vegetables used in this investigation. Acknowledgement is also made to the members of the Chemistry and Botany Departments of the University of Miami for their helpful suggestions offered during the course of this study.

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# PRESENT STATUS OF THE WIREWORM PROBLEM IN SOUTH FLORIDA

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Wireworms are the immature stage of the click beetle and often cause severe damage to a number of crops grown in south Florida. The problem of controlling a soil inhabiting insect such as wireworms is often a very difficult one and is frequently an expensive operation. Wireworm control has engaged the attention of entomologist in all sections of the United States and many of the crop producing areas of the world. As a result of the work on wireworms a large number of papers have been published. The number of recommended control measures is also very extensive, but unfortunately, none of them are entirely satisfactory.

Twelve species of wireworms have been collected in south Florida but only two have been reported to be of economic importance in other sections of the country. These are *Melanotus communis* Gyll and *Heteroderes laurentii* Guer. The latter species has not been observed in sufficient numbers to be of economic importance in this area. The larvæ of *M. communis* truly resemble a jointed piece of bright brownish yellow wire and is approximately one and one-quarter inches in length when full grown.

Most of the crops grown in this area are subject to wireworms attack during some stage of their growth. Crops which have been observed to suffer losses as a result of wireworm injury include corn, sugarcane, gladiolus, carrots, potatoes, cabbage, lettuce, escarole, celery and pepper. The nature of the damage may be divided into three types according to the stage of plant growth injured.

The first type is injury to seed and seed pieces as in the case of corn and sugar cane seed pieces. The wireworm larvæ are attracted to the row of seed or seed pieces and may move along the row from seedling to seedling. Thus a relatively small number of wireworms can cause a disproportionately large amount of damage. The second type of injury is that inflicted on such crops as celery, lettuce and peppers which are transplanted. A loss of as much as twenty per cent of plants has been observed in celery and lettuce fields. Here again the wireworms will move along the row destroying the main root of the transplant. After the plants have become established they are able to tolerate the wireworms and apparently make a normal growth although the wireworm population may be quite high. In the case of gladiolus the wireworms usually eat their way up through the center of the corm, destroy the young plant and move on to the next corm. Here again the plants after they become well established are either able to tolerate the presence of wireworms or they lose their attractiveness to the wireworms. The third type of injury is that inflicted on root crops such as carrots and potatoes. In 1942 the potato growers in the Homestead area lost from 2000 to 3000 acres of potatoes due to wireworm attack.

Adult click beetles may be collected during all months of the year, but in very small numbers from September to March. Collections and life history studies at Belle Glade over a three year period show that the adults gradually become more abundant during March and April and are most numerous during May, June and July.

Egg deposition took place in the insectary in May and June. Some adults lived in the insectary until late September but no eggs were deposited after August 31 in any of the

years. When the females died they were dissected and found to contain from 112 to 416 eggs which had not been deposited. This indicates that conditions for oviposition in the insectary were not entirely satisfactory because most of the females deposited some viable eggs in the cages. During the three years 1940 to 1942 a total of 477 eggs were hatched in the insectary with an average duration of the incubation period of 13.2 days. During the summer of 1940 a total of 151 larvæ were placed in cages for observations on the duration of the larval period. Of these 15 adults

TABLE 1—NUMBER OF ADULT *M. COMMUNIS* GYLL. COLLECTED ON TANGLEFOOT TRAP AT BELLE GLADE.

Month	1940	1941	1943*
March		11	64
April		7	57
May	34	60	137
June	57	12	144
July	8	25	
August	0	1	
September	0	0	

\* Data Collected by Mr. N. C. Hayslip

emerged in an average of 305 days. During the summer of 1941 a total of 191 larvæ were placed in cages for observation. Again 15 adults emerged after an average of 307 days had elapsed. From observations in the field it is known that there is considerable overlapping of generations but the available data indicates that the duration of the life cycle is approximately one year and that the bulk of the eggs are deposited in May and June.

A review of the literature shows that only a small number of insect parasites attack wireworms and that these parasites are not abundant. No parasites have been observed on wireworms in south Florida.

Since the life history studies have indicated that most of the eggs are deposited in the soil during May and June this suggests flooding during the summer months to prevent oviposition. Flooding when the land is not planted

to crops and when heavy rainfall will reduce the amount of pumping required to keep the land flooded would be a comparatively inexpensive operation. The most difficult feature of such a means of control would be the building and maintenance of dykes to hold the water. Several growers in the Belle Glade area have flooded seed bed land for the control of nematodes but these lands had not been infested with wireworms and no opportunity has presented itself to observe the effectiveness of flooding to prevent oviposition. Ingram et al. (1939) have reported that experimental flooding in August near Canal Point for the control of wireworm larvæ is not effective.

A number of workers in various sections of the country have recommended fallow as an effective means of wireworm control. Field observations in the Belle Glade area bear this out. Where the fields are allowed to grow up in weeds at the end of the crop year severe wireworm damage sometimes results. However, the occurrence of large populations of wireworms has been so erratic that it has been very difficult to predict wireworm populations where apparently favorable conditions prevail.

TABLE 2—DURATION OF INCUBATION PERIOD AND LARVÆ STAGE.

Year	Number eggs	Duration of Incubation			Number larvæ	Duration larvæ and pupæ stage days.
		Min. Days	Max. Days	Ave. Days		
1940	87	12	17	15.0	15	305.3
1941	284	10	21	12.8	15	307.4
1942	106	9	15	11.9		
Total	477			13.2	30	306.3

To test the effectiveness of fallow as compared with various cover crops an experiment was set up in 1940. At the end of the crop year plots in a latin square arrangement were planted to soybeans, cowpeas, velvet beans,

grass and weeds and fallow. Samples were taken at the beginning and end of the experiment to determine the effect of the treatment upon the wireworm population. This experiment was repeated during the summers of 1941 and 1942. The plots receiving fallow treatment showed decreases in wireworm populations during the summers of 1940 and 1942 but an in-

crease in population occurred during the summer of 1941. In cover crop plots and the plot where grass and weeds were allowed to grow increases in wireworm population occurred as was expected except in the grass and weed plots during 1941 when a decrease in population was recorded.

Soil fumigants have been tested and recommended for use on a limited scale in other sections of the United States. In November 1938 a preliminary experiment was set up to test the following fumigants for wireworm control in peat soils: Chloropicrin, carbon bisulfide and cynogas. Measured quantities of the liquid fumigants were poured into three inch holes six inches apart. The cyanogas was broadcast and spaded into the soil. In each plot two screen cages, each containing 25 wireworms were buried, one three inches below the soil surface and the other six inches below the surface. The soil temperature at the time was 80° F. After the application of the materials was completed the plots were covered with a heavy tarpaulin which remained in place for 48 hours when the cages were examined.

Chloropicrin at the rate of 600 pounds per acre and carbon bisulfide at 1380 pounds per acre gave complete control but the cost of

these materials make such dosages prohibitive for general use. Campbell and Stone (1937) found that 5 milliliters of dichloroethyl ether per gallon of water and using 8 gallons of the solution to 100 feet of row killed 94.7 per cent of *Limoni* *californicus* larvæ when the solution was drilled into the soil. Pepper (1940) working in New

Jersey reported that where one milliliter of dichloroethyl ether in one-half pint of water was applied per plant to cabbage, cauliflower, kale and broccoli, 98 to 99 per cent control of wireworms was obtained without injury to the

TABLE 4—RESULTS OF TREATMENTS WITH VARIOUS SOIL FUMIGANTS APPLIED TO PEAT SOIL.

Treatment lbs./acre	Number larvæ alive 48 hrs. after treatment		Percent Control
	Cage 3" deep	Cage 6" deep	
Chloropicrin 300	7	11	36
Chloropicrin 600	0	0	100
Carbon bisulfide 1380	0	0	100
Cyanogas 300	24	23*	0
Check	22*	24*	0

\* 2, 3 and 1 larvæ missing

plants. With these reports in mind greenhouse and field experiments were conducted to test the effectiveness of this material in peat soils.

In a field being planted to gladiolus soil sampling revealed a population of 1.8 wireworms

TABLE 3—WIREWORM POPULATION INCREASE AFTER SUMMER COVER CROP AND FALLOW TREATMENT CALCULATED ON ACRE BASIS.

Year	Grass & Weeds	Number of Wireworms			Fallow
		Soybeans	Cowpeas	Velvet Beans	
1940	+ 19,221	+ 1,960	— 1,252	— 1,742	— 1,961
1941	— 19,424	+64,469	+67,082	+53,344	+13,068
1942	+148,140				—17,424



per cubic foot of soil. One-hundred foot plots were laid out in triplicate. Four concentrations of dichloroethyl ether were used ranging from 15 to 50 milliliters of dichloroethyl ether per 100 feet of row was used. The desired amount of dichloroethyl ether was placed in five gallons of water containing 0.5 per cent aresklene as a dispersing agent. Five gallons of the solution was applied to each 100 feet of row just before the corms were covered. Four concentrations of dichloroethyl ether were used ranging from 15 to 50 milliliters of dichloroethyl ether per 100 feet of row. A fifth treatment consisting of 500 pounds per acre of ground tobacco stems and an untreated plot completed the experimental arrangement. The effectiveness of the treatments was measured by recording the number of gladiolus plants which had been destroyed by wireworms 37 days after the materials were applied. Although a strong odor of dichloroethyl ether persisted in the soil for four weeks there were as many or more destroyed plants in the treated plots as in the untreated plots. Dosages of one-half milliliter to 15 milliliters in one-half pint of water and 0.5% aresklene were applied to potted lettuce plants in the greenhouse. The 2 milliliter per plant dosage failed to kill the wireworms and the 5 ml. dosage severely injured the plants. Therefore, dosages ranging from 1 1/2 ml. to 3 1/2 ml. per plant were applied to replicated plots of lettuce which had been transplanted from the seed bed one week previous to the treatment. The soil was very dry at the time of application and it was a warm cloudy day. Eighty-six per cent of the plants were

killed by the dichloroethyl ether. Under climatic conditions prevailing in south Florida dichloroethyl ether is not safe to use on newly transplanted lettuce. There has been no opportunity to test it on other plants but in view of the experience with lettuce it should be used only in experimental plots.

Baits consisting of wheat or corn treated with a sticker and one of the following poisons: tartar emetic, thallium sulphate, potassium fluoride, zinc phosphide and zinc phosphite have been tested in the laboratory. None of these gave promising results in the laboratory trials. Corn which had been stored with paradichlorobenzene or naphthalene for the control of storage insects was planted in wireworm plots to determine whether or not these materials would protect the germinating grain. Corn treated with both paradichlorobenzene and naphthalene was as severely attacked as the untreated grain.

Of the methods of control tested the most practical for general use in the control of wireworms is clean cultivation during May, June and July to prevent the adult beetles from depositing eggs in the soil.

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# THE EFFECTIVENESS OF CERTAIN FUNGICIDES IN CONTROL OF LATE BLIGHT OF TOMATO

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Late blight (*Phytophthora infestans* (Mont.) DBy.) first appeared in tomato fields in the Homestead area this season during the early part of January 1946. Within two weeks the disease spread to approximately 90% of the local plantings. Due to the virulence of the organism and its wide dissemination, the 1946 crop sustained the worst attack of late blight in recent years. Tomato fields in sections of South Dade County below the Royal Palm State Park, that had never before been affected, were blighted early in the season and suffered heavy losses.

The 1946 season marked the first opportunity to test the newer fungicides under severe blight conditions in Dade County. In 1944 and 1945 some of the new fungicides were tested on tomatoes, but there was not sufficient disease present to properly evaluate the materials, late blight appearing only as a trace in 1944 and none in 1945.

The tests this year were conducted on Grothen Globe tomatoes planted in Perrine marl soil. The plots contained thirty-six plants planted in two rows, the rows being six feet apart and the plants two feet apart in the row. Nine tests and the untreated check were randomized in each of four replicate blocks. They were planted on the 28th of January, 1946, and all received uniform fertilization.

Since the plants were quite small when set, it was thought inadvisable to begin spraying until they had become established even though nearby commercial tomato fields planted earlier

were heavily infested. As a result, when the first spray applications were made on February 11, 1946, late blight was found to be uniformly distributed throughout all the plots. The first two applications were made at 7-day intervals but since late blight was increasing in all plots, the interval between sprays was shortened to 5 days. The 5-day schedule was followed for the ten subsequent applications. The power sprayer used gave a working pressure of 400 pounds, and the fungicides were applied at a rate of approximately 125 gallons per acre. There was no indication of spray burn or other deleterious effect from the 5-day spray schedule.

The plots were harvested five times. The fruit was picked mature-green in accordance with commercial practice, and graded in line with requirements of U. S. standards.

The figures covering total yields of marketable fruit were analyzed statistically to determine the effectiveness of the fungicides tested. The results are shown in Table I.

As indicated in Table I, all the dithio-carbamate sprays, with the exception of Zerlate, controlled late blight in the field under extremely severe blight conditions. The highest yielding plot was sprayed with Dithane-zinc sulfate-lime, and the next highest with a dithio-carbamate reaction product of DuPont. The third highest yielding plot was sprayed with Dithane-zinc-lime to which an oil spreader-sticker was added, and the fourth highest with a Dithane reaction product of Rohm & Haas. There is no statistically significant difference between these four highest yielding plots.

Without exception the carbamates gave equally good control of the moderately heavy attack of early blight (*Alternaria solani* (Ell. and Martin) (Jones and Grout)), which was also present in the plots. Photographic differ-

ences between plots were not as pronounced as might have been expected due to a heavy infestation in all plots by a leaf miner (*Liriomyza pusilla* (Meig.)).<sup>1</sup> There was no apparent difference in infestation attributable to

amendment. DDT was used in spray No. 6 (Table I) at the rate of 1/8th of 1% by weight (2 lbs. of 50% DDT per 100 gallons), at each application. All other sprays and the check received one application of lead arsenate

TABLE I—YIELDS IN MATURE-GREEN FRUIT FROM GROTHEN GLOBE TOMATOES IN FUNGICIDE TESTS, HOMESTEAD, FLORIDA, 1946.

No.	Materials	Formulas (qts.-lbs.-gals.)	Marketable fruit - Bu. per Acre	Increase over check Bu per acre
1.	Dithane D-14-zinc sulfate lime (a)	2-1-0.5-100	247	182
2.	Dithio-carbamate Reaction Product No. IN-5446 (b)	2-100	225	160
3.	Dithane D-14-zinc sulfate-lime plus ACX-105 (c)	2-1-0.5-4 qts.-100	224	159
4.	Dithane Reaction Product (d)	2.5-100	222	157
5.	Phygon-zinc sulfate-lime (e)	0.5-1-0.5-100	204	139
6.	Dithane D-15-zinc sulfate-lime, plus DDT (f)	2-1-0.5-2-100	169	104
7.	Tri-basic copper-zinc sulfate-lime, plus DDT (g)	4-1-0.5-2-100	151	86
8.	Zinc-chromate 169-A (h)	5-1-100	137	72
9.	Zerlate (i)	2-100	136	71
10	Check — no fungicide		65	

Difference required for significance with odds 19:1 equal 28 bu.

Difference required for significance with odds 99:1 equal 38 bu.

- (a) Disodium ethylene bisdithiocarbamate
- (b) Dithio-carbamate Reaction Product of DuPont
- (c) ACX-105—Shell Oil spreader-sticker
- (d) Dithane Reaction Product of Rohm & Haas
- (e) U. S. Rubber Co. 2, 3-dichloro-1, 4-naphthoquinone
- (f) Dichloro-diphenyl-trichloroethane
- (g) Tenn. Tri-basic Copper
- (h) Crop Protection Institute No. 169-A
- (i) Zinc dimethyldithio-carbamate

treatments.

Since there had been no previous field-plot work done in this area with DDT<sup>2</sup> in tomato fungicides, this material was added as a spray

at the rate of 4 pounds per 100 gallons. The results are shown in Table II.

It will be noted from Table II that there is a significant difference between the plot sprayed with Dithane-zinc sulfate-lime and the plot sprayed with the same materials to which DDT was added. It is apparent that the addition of DDT to the spray decreased the yield.

<sup>1</sup> Determined by Dr. G. T. Greene, U.S.D.A., Bureau of Entomology and Plant Quarantine.

<sup>2</sup> Dichloro-diphenyl-trichloroethane.

TABLE II—EFFECT ON YIELD OF MATURE-GREEN GROTHEN GLOBE TOMATOES DUE TO THE ADDITION OF DDT TO SPRAY.

Material	Marketable fruit yield, Bu. per Acre	Difference between treatments Bu. per Acre
Dithane D-14, ZnSO <sup>4</sup> -lime	247	
Dithane D-14, ZnSO <sup>4</sup> , lime plus DDT @ 2 lbs. 50% per 100 gallons	169	78

Difference required for significance with odds 19:1 equal 28 bu.

Difference required for significance with odds 99:1 equal 38 bu.

Although Gardner, Michelbacher, and Smith<sup>1</sup> in greenhouse tests for thrips control, state that the application of DDT gives evidence of reduced yields, it is believed that the data as shown in Table II is the first instance of this effect being measured quantitatively through actual yields.

<sup>1</sup> "Spraying with DDT in a Greenhouse to Control Thrips, the Vectors of Spotted Wilt in Tomatoes." Gardner, M. W., A. E. Michelbacher, and Ray E. Smith. Investigations with DDT in California, 1944. Univ. of Calif., March 1945: 24-27.

## TRANSPLANTING CABBAGE

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### INTRODUCTION

Cabbage is an important vegetable crop in Florida. It is grown during the fall, winter and spring months for shipment to northern markets for consumption as fresh, green cabbage. According to the Annual Fruit and Vegetable Report of the Florida State Marketing Bureau, cabbage was grown on 17,500 acres of Florida soil during the 1944-45 season. Average yield for the state was 7.5 tons an acre and when packed and loaded at shipping points, the gross value of the crop was a little above three and three-quarter million dollars. In acreage grown in 1944-45, cabbage was exceeded by 4 vegetables, namely, snap beans, watermelons, tomatoes and potatoes. When packed and loaded at shipping point, the gross value of

each of 6 vegetables, tomatoes, celery, snap beans, potatoes, peppers and watermelons was greater than that of cabbage.

Members of the Florida Agricultural Experiment Station have done and are doing considerable work to increase the yield and quality of cabbage grown in Florida. Some of the problems which are receiving constant attention are (1) varieties best adapted to the various producing areas and acceptable on northern markets, (2) methods of controlling diseases and insects which destroy or lower market value and (3) methods of fertilization as well as other cultural practices which will result in good yields of high quality cabbage.

One of the important problems in producing cabbage in Florida is transplanting the plants and getting them started to grow in the field. Particularly is this true of crops which are transplanted in the warm weather of early fall, September and October, to produce cabbage for market early in December. Cabbage

plants grow best in relatively cool weather and enough plants are not grown in Florida to set commercial acreages in September and October. Consequently, millions of plants are imported into the State from plants growers in North Carolina, Georgia and other nearby states for setting the early acreage. Many of these plants arrive in poor condition and are not easily transplanted so they will live and produce a crop. Later in the fall temperatures are lower and most of the plants for setting the later commercial acreage are grown in Florida. The hazards encountered in transplanting plants in cooler weather are less and the crop is easier started in the fall and winter.

This paper consists of a brief discussion of transplanting cabbage. It is based on information gained by growing several hundred experimental plots of cabbage at the Potato Laboratory at Hastings, Florida and on observations of the practices followed by commercial cabbage growers in Florida.

#### TRANSPLANTING IN EARLY FALL

Usually the Copenhagen Market variety of cabbage is used for early plantings, those made during September and October. Tests have shown that there are 2 types of this variety, one producing smaller plants and attaining marketable size 2 to 3 weeks earlier than the other one. If the large, later type is used for early plantings, harvest is delayed and there may be much disappointment with the crop. Since the 2 types are often sold and distributed under the common name, Copenhagen Market, the grower should ask for the particular type he plans to grow. Furthermore, plants grown from 2 or more lots of seed should not be planted together in the same row or field, unless it is definitely known that they will mature at about the same time. Otherwise they may mature separately and cause unnecessary labor and expense in harvesting.

For best results with cabbage transplanted in the warm weather of September and October the land should be well prepared. If at all possible and not prevented by rains, the land should be disked and partially prepared 3 to

4 weeks in advance of setting the plants. Advanced disking will cut the weed and cover crop growth into the soil and give it time to partially decompose and be out of the way of the transplanting operations. Soil organisms which decompose weed and crop growth use nitrogen. If the decomposition is about completed before the land is fertilized all of the nitrogen in the fertilizer may be used by the growing plants.

The soil should be fertilized 10 days to 2 weeks before the plants are transplanted especially if the fertilizer is applied broadcast on a low row and covered with bedders, as usually practiced in the Hastings area. In this area a 5-7-5 fertilizer is generally applied at the rate of 1 ton per acre for cabbage and this is followed at intervals after the plants are set with 2 to 3 applications of nitrate of potash side-dressing at rates varying from 100 to 200 pounds per acre at each application. Tests at the Potato Laboratory at Hastings, Florida as reported at the last meeting of this Society, show that good yields of cabbage may be obtained by applying a 10-7-5 fertilizer at the rate of 1 ton per acre in the row prior to transplanting and dispensing with the side-dressing. Advanced application of the fertilizer gives time for it to dissolve and become mixed in the soil solution so as not to injure the plant roots when they are transplanted. When the fertilizer is applied in a band in both sides of the row the plants may be set immediately after it is applied, care being taken to see that they are placed in the row between the bands to prevent burning.

Cabbage fields must be protected against flooding during heavy rains. On level land where drainage canals and ditches are not provided with pumps, the rows for cabbage should be bedded 8 to 10 inches high and cross drains provided at all low places in the field to carry the water into water furrows and into drainage ditches.

Special care and handling will be necessary with cabbage plants that are transplanted in warm weather. Best results are likely to be had with home-grown plants which can be pulled from the plant bed and transplanted

within a few hours. Even these plants should be shaded from the time they are pulled until transplanted. If exposed to the sun and wind the plants will dry out and wilt and many of them will fail to grow after they are transplanted. When it is necessary to purchase plants at a distance or import them from out of the State and transplant them in warm weather, it will be very difficult to get a satisfactory stand. Such plants may be 1 or 2 days in transit. When they are received the containers should be placed in a shed or shady place protected from the wind and opened. If the plants are tightly packed in the containers and they can not be transplanted immediately, part of the plants in each container should be removed and placed in other containers. It may also be advisable to sprinkle some water on the plants to run down on the roots and prevent them from drying and fluffing off.

Soil in which cabbage plants are to be transplanted in warm weather should be fairly moist or wet. Unless it is quite moist from recent rains it should be irrigated. If an overhead irrigation system is available it can be employed to wet the soil down to a depth of 3 or 4 inches just before the plants are transplanted. When overhead irrigation is not available water furrows and field ditches may be filled with water and kept full until water seeps out and moistens the soil so the plants can be transplanted. The water should be lowered or drained out of the ditches, however, before the soil in the rows is moist or wet at the surface or it will be too wet for good growth of cabbage.

Prior to setting the plants the rows should be marked to indicate where the individual plants are to be set. Markers in the Hastings area are wood or steel drums 2 to 3 feet in diameter with pieces of wood or iron fastened the long way of the drums on the outer surface and spaced 9 to 12 inches apart around the drum. When pulled or rolled along the row the marker makes a depression 9 to 12 inches apart on the row, indicating places for the plants.

Plants may now be loaded and hauled to the

field for transplanting. They should be protected from sun and wind by being covered or left in containers until needed for transplanting. In transplanting one laborer, a "dropper", should drop the plants on the mark in the row, while a second laborer, a "setter", should follow and transplant. The plant is picked up off the row with the left hand and at the same time a hole is made in the soil in the mark or depression with a dibble or peg held in the right hand. The plant is then placed in the opening and the dibble or peg is pushed into the soil near the opening to press the soil to the roots and stem of the plant. Soil should completely fill the bottom of the opening and press firmly against the roots of the plant. If properly transplanted the plant should not be easily pulled from the soil when it is grasped by the top leaf. Plants should be dropped on the row only a little in advance of the "setter" to prevent injury by sun and wind. After some practice transplanting can be done quickly and efficiently by this method.

When overhead irrigation is available it may be used to apply a light irrigation within a few hours after the plants are transplanted. This irrigation moistens the soil and more completely firms it to the roots of the plants, enabling them to start growth quickly. If overhead irrigation is unavailable water may be carried from the water furrows or field ditches and a small cupful poured around the plant within a few hours after the plants are transplanted.

In the last few years with the shortage of labor, transplanting machines have been used to transplant cabbage in Florida. Essentially, they consist of a frame mounted on wheels or directly to a tractor and carry a shoe or device to open a furrow for the plants, seats for two laborers, a water tank with a method of releasing water at the roots of the plants and two rollers or slides to firm the soil about the roots of the plants when they are set. Some transplanting machines are made for transplanting two rows in one operation. Some have also been designed for accurate spacing of the plants, while with others, spacing of the plants is left to the laborers who place the plants.

Transplanting machines are efficient when properly pulled along the row at a slow steady rate. For operation they require a driver for a tractor, 2 to 4 laborers to place plants and another laborer to ride the machine and arrange plants for the laborers who are placing them. It is also necessary that other help be available to keep up a supply of plants and water so the transplanting machine may operate continuously.

When transplanting machines are used to transplant cabbage in warm weather the soil should be moist or wet either from recent rains or from overhead or seep irrigation as described above. After the plants are pulled from the plant bed they should be protected from the sun and wind and transplanted as quickly as possible. Water should be kept in the water tank of the transplanting machine so the plant roots can be well watered when the plants are transplanted.

Whatever method of transplanting is used when the weather continues warm without rainfall, the plants may require further irrigation or watering 10 days or 2 weeks after they are transplanted to keep them alive and growing until cooler weather.

#### TRANSPLANTING IN LATE FALL AND WINTER

Early maturity is not an important factor in Florida with late fall and winter plantings of cabbage. Many varieties are used for producing these crops, but Copenhagen Market, Glory of Enkhuizen and Midseason Market are grown more extensively than others. Glory of Enkhuizen and Midseason Market require 2 to 3 weeks longer to attain marketable size than the early type Copenhagen Market, but they mature

along with the large, later type of this variety. When permitted full development and harvested at the proper time Enkhuizen and Midseason generally outyield Early Copenhagen. Yields of the large, later type Copenhagen may equal those of Glory of Enkhuizen and Midseason. Regardless of the variety used, any one planting should be with plants grown from the same seed. If plants are grown from 2 or more lots of seed and planted together in the same row or field they may mature unevenly. As indicated above, this is particularly true when the Copenhagen Market variety is planted.

For late fall and winter plantings the soil should also be disked and partially prepared several weeks in advance of transplanting the plants. Rains are less frequent at this time of the year and should not prevent early preparation. As for early plantings, the soil should be fertilized 10 days to 2 weeks in advance of transplanting, especially if the fertilizer is not placed in bands in the row. Good drainage should be provided to prevent flooding of the field in the event of heavy rains.

Most of the plants for setting the late fall and winter cabbage acreage in Florida are home-grown. The transplanting operation for these plants is the same as that described for those transplanted in the warm weather of early fall. However, since temperatures are lower and the plants are usually pulled from the plant bed and transplanted in a few hours, good stands of plants may be obtained with less care in transplanting. If the soil is dry one irrigation or watering immediately before or after the plants are set may be sufficient. Further irrigation or watering should not be needed unless rainfall is deficient for a considerable period after the plants are set.

# CONTROL OF TOMATO LATE BLIGHT IN SEED BEDS

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Late blight caused by the fungus *Phytophthora infestans* has been unusually severe on tomatoes in many areas of Florida this season. It was first observed late in November but it was not until the middle of January that it became wide spread and extremely destructive in many areas of the State. The disease has been observed on potatoes practically every year since potatoes have been grown in Florida, but only occasionally on tomatoes where its appearance has usually been confined to the lower east coast and south Florida. It has been reported in tomato seed beds in some sections of the United States but very infrequently. It had never been reported on tomato seedlings from the West Coast area of Florida as far as the writer is aware. Consequently when the disease made its sudden and destructive appearance on tomato seed beds in Manatee and Hillsborough counties in January no one was prepared for the onslaught. It was during this period that all control measures appeared to fail. This apparent failure to get good control of late blight resulted from lack of a good spray program, failure to get thorough coverage and failure to start spraying in time. A few growers who consistently followed recommendations came through with good plants. Growers who jumped from one spray to another or did not get coverage, or apply sprays frequently enough lost most of their early plants. A conservative estimate is that better than 85 percent of early seed bed plants were lost because of late blight. Later plantings came through much better, partly because of a change in the weather and partly because of a better spray program.

Experiments conducted by Dr. G. D. Ruehle at the Sub-Tropical Experiment Station, Homestead, Fla., have demonstrated that a spray made up of Dithane 2 quarts, zinc sulfate 1 lb. and lime 1/2 lb. to 100 gallons of water has given the best control of late blight on potatoes of all materials tested. Recent tests at the Vegetable Crops Laboratory at Bradenton have confirmed this spray as the best commercially available spray material for the control of this disease on tomatoes on the Florida West Coast. These experiments at Bradenton have been confined mostly to tomato seed bed tests where the fungicides were put on at various time intervals.

The first experiment was conducted on a seed bed near Ellenton planted Jan. 25 adjacent to several beds that had been abandoned because of late blight. The tomato seed, variety Rutgers, was sown in broad rows about 6 inches apart across the bed. Each spray plot consisted of 7 rows about 3 feet long. There were 3 plots for each treatment. Each plot was divided so that 4 rows were sprayed twice a week and the other 3 rows only once a week. The first sprays were applied on Feb. 6. The half plots receiving sprays once a week had 4 applications and those receiving sprays twice a week had 8 applications. The last application was made on March 2 when the plants were 6-8 inches high and were ready for field setting. All sprays were applied with a knapsack sprayer and screens were used between plots so that spray drift did not occur from plot to plot.

Late blight was not observed in any of the plots until Feb. 23 when several centers of infection were observed in each check. The weather turned extremely favorable for the spread of late blight Feb. 27. It spread with extreme rapidity over the check plots and some of the other treatments. Efficiency ratings for the different sprays were made on March 7 by classifying 25 plants from each end of



the plot. The same relative position was taken for each sample from each sub-plot. Four classes were used, plants dead, severely affected, slightly affected and no symptoms evident. Weights of 0, 1, 2 and 4 were given the respective classes. Thus a rating of 100 indicates that no lesions of late blight were observed on any of the 25 plants in the sample and a rating of 0 means all plants were dead. The data are presented in Table I and indicate that late blight was effectively controlled by both the Dithane and IN5446 sprays. Spraying twice a week was more effective than spraying once a week.

TABLE I—EFFECT OF SOME ORGANIC SPRAYS ON THE CONTROL OF LATE BLIGHT IN TOMATO SEED BEDS.

Treatment	Efficiency Rating on Plants Sprayed		
	Weekly	Semi-Weekly	Total
Copper A Compound 4 lbs.-100	124	182	306
Dithane D14 2 qts. zinc sulfate			
1 lb. lime 1/2 lb-100	205	260	465
Crop Protection Institute			
169A 4-100	74	148	222
IN 5446 1 1/4-100 (a)	179	256	435
Zerlate 2-100	60	75	135
Check	0	0	0
Totals	642	921	

Differences required for significance at 19:1

Spray totals 84

Frequency totals 125

(a) Furnished by the E. I. DuPont de Nemours Co.

The second experiment was conducted on some tomato seed beds at the Vegetable Crops Laboratory at approximately the same time as the Ellenton experiments and with a similar set up, the only difference being that three additional sprays were used and that there were 8 rows to each spray plot (4 sprayed once

a week and 4 twice a week) and 4 randomized applications. The beds were sown with Rutgers tomato seed on Feb. 1. The first application of spray materials was made on Feb 13. The last application was made on March 16.

The plots, sprayed once a week, received 5 applications of spray materials and those twice a week 10 applications, except that after the spray of March 6, 3 sprays were dropped because of their failure to hold late blight. Efficiency ratings were made on the various plots at four different dates, using the same system as in the previous test. The results are presented in Table 2.

The results of this test confirmed the findings of the previous test, namely that late blight can be held in check in tomato seed beds even under epiphytotic conditions.

A third experiment was conducted in which the best spray materials from the first two experiments were included plus several new ones. The same general procedure was used as in the previous tests. The beds were planted with Rutgers tomato seed on March 15 adjacent to the beds used in experiment 2. The first spray was applied on March 25 and repeated at intervals of 3 to 6 days. Five applications were made, the last on April 11.

The weather was not favorable for the rapid spread of late blight but nevertheless some differences were obtained between the different treatments. Efficiency ratings for the spray materials were made on April 13 and 22 using the same procedure as in the previous tests. The data which are presented in Table 3 again demonstrate that late blight may be controlled in tomato seed beds when the foliage has been thoroughly covered. Dithane, zinc sulfate and lime again held late blight in check. IN5446 and He178E and Phygon were slightly superior though not significantly so to the standard Dithane, zinc sulfate and lime. Dithane, zinc sulfate, lime and ammonia caused severe injury to the seedlings and did not give as good disease control as some of the other treatments. Dithane, zinc sulfate and ammonia was superior to the Dithane, zinc sulfate, lime and ammonia.

TABLE 2—EFFECT OF SOME ORGANIC SPRAYS ON THE CONTROL OF LATE BLIGHT ON TOMATO SEED BEDS.

Treatment	Efficiency Rating on March				
	5	15	21	30	
	Semi- Weekly Total	Semi- Weekly Total	Semi- Weekly Total	Semi- Weekly Total	
Copper A 4-100	360	360	720	360	720
Dithane *	380	400	780	380	760
Dithane ammonia *	400	400	800	400	800
IN 5446 1 1/4-100 *	400	400	800	400	800
Hel78B 1 1/4-100 *	440	380	720	440	880
CPI 169A 4-100	200	260	460	200	400
Zerlate 2-100	160	240	400	160	320
N. I. Ceresan 1-250	140	200	340	140	280
Check	40	40	80	40	80

Difference required for significance

at 19:1

124

132

131

103

\* Dithane D14 2 quarts, zinc sulfate 1 lb., hydrated lime 1/2#, water 100 gal.

\* Dithane D14 2 quarts, zinc sulfate 1 lb., commercial ammonia 2 quarts, water 100 gal.

\* Furnished by E. I. duPont de Nemours Co.

\* Furnished by Rohm &amp; Haas Company

All Dithane combinations that have been used have caused some injury to tomato seedlings, the younger the plants the more severe the injury. The injury appears to be more serious during warm than during cool weather, and is more or less dependent on frequency and rate of application.

Dithane sprayed tomato seedlings are short and stocky and, in severe cases of injury, will

have the terminal bud destroyed so that the plant will have to develop from suckers. The leaves usually are narrow, more or less filiform, almost resembling a plant affected with shoestring mosaic.

Dithane injured tomato seedlings rapidly outgrow the injury when they are set to the field. Even in cases of severe injury Dithane sprayed plants are delayed only a few days.

No injury has ever been observed from using Dithane on large tomato plants in the field.

TABLE 3—EFFECT OF SOME ORGANIC SPRAYS ON THE CONTROL OF LATE BLIGHT IN TOMATO SEED BEDS.

Treatment	Efficiency Rating in April	
	13	23
Copper A 4-100	272	201
Copper 8 quinolinolate 1-100	273	176
Super copper <sup>1</sup>	288	205
Standard Dithane and Copper A 4-100 alternating	300	238
Dithane, zinc sulfate and lime, 2 qts., 1 lb., 1/2 lb.-100	300	254
Dithane, zinc sulfate, lime and ammonia, 2 qts., 1 lb., 1/2 lb. 1 qt.-100	300	236
Dithane, zinc sulfate and ammonia 2 qts., 1 lb., 1 qt.-100	300	268
IN5446 1 3/4-100 <sup>2</sup>	300	272
He178E 1 3/4-100 <sup>3</sup>	300	260
IN 7331 1 1/2-100 <sup>2</sup>	296	222
Phygon 1/2-100 <sup>4</sup>	300	274
Puratized N5E <sup>5</sup>	201	130
Check	137	62
Difference required for significance at 19:1	36	34
Maximum rating 300		

<sup>1</sup> First two applications made at 1 gal.-400 gal. rest 1 gal.-300 gal.

<sup>2</sup> Furnished by the E. I. duPont de Nemours & Co.

<sup>3</sup> Furnished by the Rohm and Haas Company.

<sup>4</sup> First application was made at 1-100 but because of some spotting on the leaves the concentration was cut to 1/2-100 for all later applications. No injury was noticed at this concentration.

<sup>5</sup> At first used at 1 part to 2000 of a 10% solution but later the concentration was cut to 1 part to 4000 because of plant injury.

#### DISCUSSION AND SUMMARY

Three separate experiments have demonstrated that late blight *Phytophthora infestans* can be controlled in tomato seed beds even under epiphytotic conditions. Dithane, zinc sulfate and lime consistently gave good control of late blight although there was some injury on the young seedlings. Frequency and rate of applications were factors which governed the severity of Dithane injury. The more frequent and the heavier the applications the more severe was the Dithane injury. High temperatures also appeared to increase the injury. Ammonia was a satisfactory substitute for the lime in the Dithane spray but both should not be used in the same spray mix at standard strengths on young tomato seedlings because of injury.

The new sprays IN5446 and He178 which are different formulations of zinc ethylene bis-dithiocarbamate, the active ingredient of the Dithane spray mix, are extremely promising fungicides. They are as effective as Dithane in controlling late blight when used at equal strengths and furthermore have failed to cause any plant injury even when applied twice a week.

Phygon gave excellent control of late blight in the one test in which it was used. There was some seedling injury when used at 1-100 but not at 1/2-100.

Copper A compound, copper 8 quinolinolate and Super Copper all gave fair to good control of late blight while the plants were very

small, but failed to hold the disease in check satisfactorily when the plants started to crowd each other.

Zerlate did not control late blight.

C.P.I. 169A, Puratized N5E and New Improved Ceresan did not control late blight and

in most cases caused medium to severe seedling injury.

IN 7331 gave fairly good control of late blight though not as good as Dithane or the other Dithane related materials in the one test in which it was used.

## A FOG MACHINE FOR APPLYING INSECTICIDES

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It has been desirable to develop new types of spraying and dusting machinery to apply highly concentrated insecticides such as DDT in concentrated form. The fact that a small amount of concentrated spray atomized into small particles can be effectively applied over a large area has opened up possibilities for the application of liquid insecticides.

Recently the members of the Vegetable Crops Laboratory at Bradenton were privileged to see a fog machine, similar to those used during the war, in use as an insecticide applicator. The Todd Shipyard Corporation of New York sent one of the machines here for investigations of the application of various forms of DDT on crops. The machine, manufactured under the name of "TIFA" (Todd Insecticidal Fog Applicator) is compact and is powered with a 6 1/2 horsepower engine. Insecticidal material is atomized mechanically, then further fractionated by hot air, resulting in a fog mass of microscopic particles.

### FIELD TEST

A field of pole beans on the D. N. Thompson farm on Sneads Island, Florida, was found suitable for test purposes. It had a fairly uniformly heavy infestation of bean leafhopper *Empoasca fabae* Harris. The fog machine was mounted on the rear of a 1 1/2 ton truck. The beans had received their last picking, so were

old vines. There were 2 replications of 6 treatments each in the experiment. A plot consisted of 2 rows of beans that had vined on 2 poles joined in an inverted-V trellis. The poles were tied together in the row with string and anchored at each end. A buffer of 4 rows of beans or 2 double rows of joined poles was left between each plot. Pre-treatment counts were taken at intervals of 25, 50, 75 and 100 feet from the fog applicator. These counts were taken from 10 leaves each from the basal 1 1/2 to 2 foot interval and 10 leaves from the upper portion of the plant 1 1/2 feet to 6 feet. A leaf consisted of 3 leaflets. It was not possible to take counts 24 hours after application, hence the post treatment counts were made 48 hours after the fog application and the figures based on a 48 hour interval. The results are given in Table 1. A count as given in Table 2, taken 72 hours after treatment, showed a marked reduction in leafhoppers at the 125 and 150 foot interval from the fog applicator.

The 3 Deenate 50W fog treatments were equally effective and were as good or better than the spray application of Deenate 50W. The Deenate 25R and Deenol 25C were not significantly better than the sprayed plots. There was no difference between the use of 5% 50W DDT and 25% 50W DDT applied as a large droplet.

All DDT materials were supplied by du Pont. The 50W is a wettable powder containing 50% DDT and is used as a spray material. The Deenate 25R is an emulsifiable oil to be further diluted for use on farm animals and farm buildings where noticeable residues are not desirable. Deenol 25C is a concentrated oil

TABLE 1—SHOWING EFFECTS OF INSECTICIDE FOG ON LEAF HOPPER ON POLE BEANS. D. N. THOMPSON FARM, SNEADS ISLAND, FLA.

	Basal Portion of										Top Part of Plant Breast High										Plant Total	Decrease % Mean to															
	25'					75'					100'					25'							50'					75'					100'				
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A			B	A	B	A	B	A	B	A	B	A					
Deenate 50W	5% DDT										15	0	17	0	33	0	22	6	87	6	93	63	0	68	0	161	3	26	5	318	8	97	97				
Deenate 50W	5% DDT										50	0	30	1	18	2	19	4	117	7	94	89	0	95	1	80	2	66	12	330	15	95	95				
Deenate 50W	25% DDT										25	0	30	3	25	10	25	3	105	16	85	92	0	44	3	85	8	141	7	363	18	95	93				
Deenate 25R	5% DDT										10	0	23	1	45	2	37	8	115	11	90	95	1	126	1	97	1	116	18	434	21	95	94				
Deenol 25C	5% DDT										21	0	18	4	38	2	14	5	91	11	88	51	0	60	8	75	7	46	15	232	30	87	87				
Spray 2 lb. to 50W											30	2	13	2	16	2	32	11	91	17	81	90	1	114	5	55	1	56	51	315	58	82	81				
Deenate 50W	5% DDT										REPLICATION OF ABOVE																										
Deenate 50W	5% DDT										17	0	11	0	17	0	12	1	57	1	98	100	0	77	0	83	2	44	1	304	3	99	99				
Deenate 50W	5% DDT										28	0	17	0	25	1	10	1	80	2	97	81	0	99	4	34	0	60	10	274	3	98	98				
Deenate 50W	25% DDT										17	0	38	0	25	0	34	2	114	2	98	25	0	129	0	97	1	126	10	379	1	99.7	99				
Deenate 25R	5% DDT										29	0	30	1	27	1	39	12	125	14	89	55	0	41	0	37	2	102	21	235	23	90	90				
Deenol 25C	5% DDT										13	0	11	1	19	7	15	2	58	10	83	99	0	36	0	84	7	113	13	332	20	94	92				
Spray 2 lb. to 50W											37	10	65	4	34	1	37	17	173	32	81	120	6	44	4	90	0	100	26	354	36	90	87				
Deenate 100 gal.											37	10	65	4	34	1	37	17	173	32	81	120	6	44	4	90	0	100	26	354	36	90	87				

Date of application 3/2/46

B—counts before treatments

A—counts after 48 hours

The No. 6 treatment was applied with a  
Champion Knapsack sprayer.  
Insect count based on nymph count from 10 leaves.

solution to be further diluted as a finished spray for household and other establishments.

The small droplet fogs were made up of droplets of 10-20 microns in diameter and the large droplets of 40-60 microns. An attempt was made by manipulating the rate of travel of the truck to apply DDT at the rate of 1 pound per acre on 50 foot strips except where 25% DDT was used. In the spray application, the rate was 1 1/2 pounds of DDT per acre.

The writer visited this field on March 13 for the purpose of collecting leafhoppers for

Leafhoppers are easily disturbed, so it is reasonable to assume that any movement of the insect makes insecticidal contact that much more effective. Latta's (1) statement "that the addition of an irritant like pyrethrum would make an application more effective" would be especially desirable for certain insects.

#### THE FUTURE FOR THIS TYPE MACHINE

Everyone is agreed that the machine has possibilities, but more work is necessary to find out the best way to use it. The machine

TABLE 2—EFFECTS OF THE DDT INSECTICIDE FOG AT 125 FEET AND 150 FEET INTERVALS SNEADS ISLAND, FLA.

		Basal Portion				Top Part of Plant Breast High							
		1st Replication		2nd Replication		1st Replication		2nd Replication					
		125'	150'	125'	150'	125'	150'	125'	150'				
		B	A	B	A	B	A	B	A	B	A	B	A
Deenate 50W	5% DDT L. droplet	15		11		12		9		16		35	
Deenate 50W	5% DDT S. droplet	5		2		2		12		5		8	
Deenate 50W	25% DDT L. droplet	9		15		4		5		15		11	
Deenate 25R	5% DDT L. droplet	2		2		11		8		3		3	
Deenol 25C	5% DDT L. droplet	9		11		4		3		6		10	

These counts were made 72 hours after fogging.

identification. The treated rows in each case were remarkably free of leafhoppers. Practically every leafhopper observed was an adult. The interesting thing to the writer was that he was able to collect his specimens from the buffer rows adjoining indicating that the fog travelled on a fairly straight course down the bean trellis, with little drift to either side. There was no visible sign of injury to the bean leaves.

may be mounted on any suitable mobile carrier. It would be necessary to adjust some types of farming to conform with this means of insecticide applications. The fact remains that it is possible to force a fog of insecticide for a distance of 50 feet and obtain control, but only under the most ideal climatic conditions. It seems especially adapted to pole beans which are difficult to adequately treat with in-

secticides. Another possibility is the insecticidal treatment of staked or unstaked tomatoes. Both types of growing tomatoes present their problems in insect control.

These data are extremely meager for Florida. The treatments were made during periods particularly favorable for fog applications and not all of the data available demonstrate the fog applicator to give satisfactory insect control. There is no available information on fog applications of fungicides or less potent insecticides, where coverage and load build up may be factors.

The machine has been tried to a limited extent in various parts of the country. A limited test was conducted in Arizona and other tests have been conducted in New York State.

#### ACKNOWLEDGMENTS

The selection of fields and planning of the experiments was under the supervision of the Vegetable Crops Laboratory staff. The actual applications of the materials and the taking of data was done by the following: Mr. Frank Steinrock, Mr. Norman McDonald, Mr. Ray Melato and Mr. George Linen, representing the Todd Shipbuilding Corporation.

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# KROME MEMORIAL INSTITUTE

DR. GEO. D. RUEHLE



# MEALYBUG CONTROL STUDIES ON PINEAPPLES

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It is now generally accepted, as pointed out by Westgate (1945), that the pineapple mealybug, *Pseudococcus brevipes* (Ckll.), is present in Florida, causing wilt as in other pineapple growing areas. Control of the pineapple mealybug and/or of the ants infesting the soil and plants is, furthermore, usually considered to effect control of the wilt of pineapples, as shown by Illingworth (1931). Both oil emulsion sprays and tobacco dust treatments provide control measures of the mealybug and ants, and therefore of the wilt, although growers are still trying to learn of other, cheaper and more efficient means of wilt control. It is hoped that some of the more recently developed insecticides may be found more practicable for all Florida pineapple growers.

Before describing recent exploratory tests for ant and mealybug control, however, it appears desirable to discuss briefly some often underemphasized factors concerning the pineapple mealybug.

It is desired to note, first, that the ants and the mealybugs may be infesting plants for weeks or months before any but a careful examination would disclose their presence. This fact was a source of confusion to early workers on the pineapple wilt, and it may cause lack of sufficient and early attention by present-day growers. A plant may wilt three months or so after mealybugs attack it. In the meantime it has been a reservoir of mealybugs, some of which have moved or been moved by ants to healthy plants. Time periods for the development of wilt symptoms were reported by Carter (1945) to vary from 43 to 295 days, depending somewhat on the age of

the plant at the time of infestation. He reported that recovery from early stages of wilt could occur with complete loss of symptoms and that recovery from advanced stages occurs. Other factors reportedly affecting wilt are nitrogen fertilization, mealybug reinfestation or addition of other mealybug colonies, and different qualities or quantities of light.

Mealybug infestations may originate through one or more of three means. Infestations may arise from planting materials, slips or suckers, used to start new beds. The insects are often present in the soil at the time the beds are started. A third method is the dispersion into beds from sources outside. Repeated observations have indicated that plants around the bed margins often begin wilting before those in the centers of the beds. Although the mealybugs are able to disperse without aid from other agencies, ants undoubtedly carry mealybugs to favorable locations and aid in more rapid and widespread mealybug distribution.

The rate of mealybug growth is considered rather slow, requiring two months or more from young larvæ to female ready for reproduction. They give birth to living young, however, and males are not required for reproduction. Mealybug host plants are numerous, so that the exclusion of pineapple plants from an area for a period of time cannot be expected to provide wilt control.

Only a few mealybugs per plant are necessary to produce wilt. One per plant may do so but there are usually many more per plant inducing wilt. In an experiment involving thousands of plants, Carter (1935) reported on the percentage of plants wilting as the result of different mealybug population levels per plant. This report includes plants wilting 75 to 105 days after insect infestation. His experiments showed that five insects induced wilt in 7 percent, 25 insects induced wilt

in 25 percent, and 40 insects induced wilt in 36 percent of the plants. Pineapple wilt is caused, presumably, by salivary secretions of the mealybugs, something the insects add to the plants during the feeding process. The amount of juice extracted during feeding may, however, be a factor.

The exclusion of mealybugs from planting material used to set new beds, by methyl bromide fumigation, as reported by Osburn (1945), is one method of mealybug control. In his tests one pound of methyl bromide per 1000 cubic feet for 2 hours at temperatures of 79-88° F. successfully eliminated living pineapple mealybugs without injuring the plants. This procedure may provide practical measures of control, especially to those planting new beds. A factor with reference to this control measure is the length of time after fumigation before mealybug re-infestation may be expected.

Some characteristics and comparisons of the new insecticides DDT and hexachlorocyclohexane (666) are presented. A long-time residual effect of DDT is known. Exposure to sunlight and outdoor weathering is generally considered to cause deterioration of its toxic effects after two or three weeks. Indoors the crystals of DDT remain effective for months. In the soil DDT appears to remain active for considerable periods of time, months apparently for some insects. The more DDT applied the longer, in general, an effective residue remains for insect control. The gamma isomer of hexachlorocyclohexane (shortened to HCCH and used hereafter by this designation) is its active ingredient. Much concerning it is unknown. Its residual toxicity is less than that of DDT, ranging from several days to perhaps two weeks, according to present understanding. It is interesting to note that both materials contain much of the chemical element chlorine; DDT and HCCH consist, theoretically, of 49 and 73 percent Cl, respectively, based on weights of the elements. The HCCH is, pound for pound, as much as 15

times more toxic than DDT against some species of insects. It has an odor of mustiness which is offensive to some people. This odor will persist on food or other products for several days. Hence it should not be used on merchandisable commodities for several days or perhaps two weeks or more before they are marketed. Both materials are poison to many insects, to man and to certain other animals. These materials may be used safely if care is exercised in their application. Although most plants appear tolerant to certain spray concentrations of these materials, much more work is necessary before definite recommendations may be given for the HCCH.

#### EXPERIMENTAL RESULTS

Tests under way in southern Florida, as reported by Westgate (1945), using DDT, tobacco dust, tobacco stems and miscible oil sprays are briefly reported. Miscible oils and tobacco products effected wilt control as is commonly observed. The tests with DDT, at concentrations ordinarily employed, 3 and 5 percent dusts and 1/8 of 1 percent wettable spray, were not satisfactory. They did not effectively control ant or mealybug infestations in the pineapple beds. It seemed desirable, however, to determine effects of using stronger dosages of DDT.

*Laboratory tests.* Pineapple plants about five months old, infested with mealybugs, were dipped in liquid sprays of (1) a 0.5% and (2) a 1% wettable DDT, (3) 1 %DDT plus 1 per cent oil emulsion, and (4) a 1% oil emulsion (Volck oil). A few days later another plant, one heavily infested, was likewise immersed, dipped in a 0.08% wettable spray of HCCH. The day following treatment mealybugs were observed to have dropped to the bottom of the beaker. The plants used were not uniformly infested, hence the data given cannot be compared directly, but are considered to give some indication of treatment effects. Final counts of the mealybugs that dropped,

based on treatment, are given as follows:

DDT <sup>1</sup>	
0.5%	14
1.0%	17
1.0% plus 1% oil	48
OTHER	
1% oil	4
0.08% gamma isomer of HCCH <sup>1</sup>	142
Check	5

Most of the mealybugs fell from the 1% DDT plus 1% oil treatment. Part of the mealybugs fell from the 1% oil, and the 0.5 and 1.0% DDT treatments. The HCCH treatment, however, was very striking in having felled so many insects. Only a comparatively few mealybugs fell from the check plant.

Following the above laboratory tests growing plants were treated for the determination of plant injury. There was no observed injury resulting from DDT sprays at dosages up to 1.0% nor from HCCH up to 0.8%. In view of the above observations, field plot experiments were started.

*Field plot tests — Walker beds.* Spray applications of 0.25, 0.5 and 1% wettable DDT were made to plants, some of which were beginning to put forth flower shoots, on February 12, 1946. These beds involved dozens of plants each. Plants receiving 0.5 and 1% DDT appeared after two months to have greener, more vigorously growing new leaves, and greener fruit and top than plants treated with the 0.25% DDT or check. A mealybug colony on a 0.5% DDT-treated plant was observed to have disappeared shortly after treatment and to have remained absent for six weeks.

*Ruehle beds.* Four randomized treatments, applied on February 20, 1946, in each of three blocks, covered a total of 8 plants per treatment. These treatments were DDT% (wettable), DDT 1% plus oil 1%, oil 1 percent, and check. A few days after treatment two ant colonies about plants treated with DDT had disappeared. Many dead ants, of two com-

mon species, were observed about the plants. A mealybug colony on a plant treated with 1% DDT plus 1% oil had also disappeared.

Nine weeks after the plants were treated observations of the plants revealed infestations, given in fractions, and based on treatments listed as follows:

	DDT 1%	DDT 1% + oil 1%	Oil 1%	Check
Mealybug colonies	1/8	0	1/8	4/8
Ants	0	0	1/8	4/8

More insects were found on the check than on the treated plants as noted by the figures. Of the plants infested with mealybugs, markedly more were on the check than the treated plants. These results are interpreted as suggestive of what might occur on larger number of plants. They justify more extensive tests and observations using the different materials and promising combinations of materials.

Since the time necessary to induce wilt symptoms of pineapple is in terms of several weeks or a number of months, it may be seen that the treatments made ten weeks ago, and less, could not be expected to show marked differences. Effectiveness of the treatments, especially as measured by wilted plants which is the ultimate goal, is manifested slowly and cannot be given at this time.

#### SUMMARY

Experiments involving the use of two newly developed insecticides, DDT and HCCH, are in progress and are given a preliminary report. They offer some promise of ant control and perhaps some of mealybug control. The dosages, amounts, results expected, and any recommendations for practical application, however, must await further determinations.

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## THE ASCORBIC ACID CONTENT OF FRESH AND COMMERCIALY CANNED TAHITI (PERSIAN) LIME JUICE<sup>1</sup>

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A portion of each year's Persian lime crop is now being sent to the canneries to help meet the growing demand for canned citrus juices. During the months of July and August of last year alone, 28,609 boxes (1 3/5 bushel capacity) of limes were processed (5).

The purpose of the present investigation is twofold: first, to determine the effect of storage upon the ascorbic acid content of canned lime juice; and secondly, to compare the results obtained when metaphosphoric and acetic acids are used as extracting media in the determination of ascorbic acid in this canned product.

### MATERIAL AND METHODS

The cans of commercially processed lime juice used in this study came from a single case of juice all of which had been canned on the same day in one of Florida's processing plants. Each of the plain tin cans contained 18 fluid ounces of undiluted, unsweetened juice. After arrival at the laboratory this juice was stored at room temperature (approximately 75° F.) until analyzed. The fresh juice was extracted from limes obtained at a pack-

ing house in south Dade County. Although it was impossible to obtain paired samples of fresh and canned juices, these samples are comparable since the fresh juice was extracted from "field run" fruit which had been picked in this area at approximately the same time as that used in preparing the processed juice.

Two methods were followed in making the ascorbic acid determinations described in this paper: first, a colorimetric method essentially the same as that described by Heinze and his associates (3) in which 1% metaphosphoric acid is used in preparing the extract; and secondly, the original Bessey and King technique (1) in which 8% acetic acid is used as the extracting medium. At intervals of 30 days, four cans of juice were selected at random from the case and sampled individually. The samples of fresh juice were extracted from the halved fruits with an electric reamer. The determinations were run in duplicate on 25 ml. samples of juice by either one or both of the above methods.

### RESULTS AND DISCUSSION

The results of the analyses together with the methods of determination and the periods of storage are given in Table 1.

It is evident from these results that fresh lime juice contains a greater percentage of ascorbic acid than does the canned product. Irrespective of the method used in making the determinations, it is apparent that the ascorbic acid content of the canned juice continued to decrease with increased period of storage.

<sup>1</sup> This investigation was sponsored by the Science Research Council of the University of Miami.

The consistently higher results obtained by the Heinze-Kanapaux method as compared to those obtained by the Bessey and King technique may be due to the interference of ferrous iron present in the juice as a result of its reaction with the can. It has been found that the use of metaphosphoric acid as an extracting medium may lead to erroneously high results due to the interference of ferrous iron present in canned products (2). Pilcher and Feaster (4) have found that ferrous iron up

which acetic acid was used for the extraction.

#### ACKNOWLEDGMENT

The author wishes to acknowledge her indebtedness to the Florida Lime and Avocado Growers at Princeton, Florida, who supplied both the fruit and canned juice used in this investigation. Acknowledgment is also made to the members of the Chemistry and Botany Departments of the University of Miami for their many helpful suggestions.

TABLE 1—ASCORBIC ACID CONTENT OF PERSIAN LIME JUICE.

	Method of Determination	Period of Storage	No. of Analyses	Ascorbic Acid		
				Content per 100 ml.		Loss in canning & storage
				Average	Range	
		days		mg.	mg.	%
Fresh juice	Heinze-Kanapaux	None	8	28.9	24.5-34.0	
Canned juice	Heinze-Kanapaux	47	4	25.4	24.5-26.0	12.1
	Heinze-Kanapaux	77	4	23.5	21.5-24.4	18.7
	Heinze-Kanapaux	107	4	23.5	21.7-24.7	18.7
	Bessey and King	107	4	20.5	20.2-20.9	29.1
	Heinze-Kanapaux	137	4	23.6	23.0-24.1	18.3
	Bessey and King	137	4	19.9	19.6-20.2	31.1
	Heinze-Kanapaux	167	4	19.3	18.7-20.5	33.2
	Bessey and King	167	4	19.1	18.9-19.4	33.9

to 100 p.p.m. will not interfere with the determination of ascorbic acid if acetic acid is used as the extracting medium. It is for this reason that the original Bessey and King technique is now recommended for the determination of ascorbic acid in canned products (2).

#### SUMMARY

1. The ascorbic acid content of canned lime juice was found to decrease with increased period of storage.

2. Consistently higher results were obtained by the Heinze-Kanapaux method using metaphosphoric acid as the extracting medium than by the Bessey and King technique in

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# PROMISING NEW GUAVA VARIETIES

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The common guava, *Psidium guajava* L., is native to the American Tropics, from where it has spread to tropical and subtropical areas throughout the world. It very readily propagates itself by seeds and has become naturalized in many regions even to the extent of becoming a weed pest (7).

Fruit from the wild plants generally is of inferior quality, but is utilized in the manufacture of various guava products, the most common and well known being the almost universally liked guava jelly. The fruit may be processed in many other ways. It may be canned or preserved, or made into butters, pastes, relishes, or drinks (9).

During the war military demands for cheap sources of vitamin C to fortify rations used by the armed forces brought the guava into prominence, since this fruit is one of the best known natural sources of ascorbic acid. The fruit is also valuable for its high acid and pectin content. Guava puree has been added to berries, grapes, pineapples and other fruits to raise the level of these properties in the final products. The addition of guava is said to improve the flavor of such combination fruit products. According to Coit (1), "A highly concentrated puree or paste is finding increased use in this country as a component part of many confections, notably children's candy bars." It is probable that the guava with its unique combination of desirable characteristics will find wider use in the future in the processing of various fruit products both in the home and in processing plants.

The guava does not rate very highly for use as a fresh fruit. The great majority of individuals who have become acquainted with this fruit are willing to agree with Popenoe

(7) that "it takes a very courageous soul to go into ecstasies over the merits of the fruit," and many dislike extremely the strong penetrating odor of the average common guava. It is true that the fruit from the average wild tree is almost worthless for use as dessert fruit. On the other hand, individual seedlings of superior quality may be found in almost any large planting of guavas. It is natural that an extreme variation in type and quality of fruit should exist in a species which has been grown from seed for many years under widely different soil and climatic conditions.

The guava has been neglected by horticulturists and plant breeders until quite recently. A start has now been made in California and Florida in the selection and propagation of superior varieties. A beginning has also been made in the systematic crossing of desirable strains in an effort to create more desirable types. A great deal of such work is necessary if the guava is to be raised to the position it deserves in commercial and home plantings. The writer feels that the chances for success in such work with the guava are very good.

The first guava variety to attract attention in Florida was the Redland, described in 1941 by Lynch and Wolfe (2). Fruit of this variety from young trees is very large (up to 16 ounces), firm, white fleshed, with relatively few seeds and with little of the strong odor characteristic of most of the common guavas. Subsequent study revealed that its foliage and fruit are extremely susceptible to spotting by the red alga, *Cephaleuros virescens* Kuntze (8), that the ascorbic acid content of its fruit is very low for guavas (3), and that fruit from older trees is quite variable in size. Since its flavor is very mild and is rated as inferior to fruit of some of the newer selections, the Redland is no longer recommended unless one desires an especially mild flavored guava.

Three newer selections made at the Sub-Tropical Experiment Station are superior to

the Redland in quality and possess sufficient merit to be propagated for distribution by nurserymen. They are described herein for the first time.

#### SUPREME

*Origin.* The Supreme guava is a seedling selection from seed planted in 1936 by the writer. The original tree is at 9 N.E. 14th Street, Homestead, Florida, where it was planted in 1938, and several grafted trees are growing at the Sub-Tropical Experiment Station.

*Tree.* The tree is a vigorous grower, becoming quite large, spreading, with a fairly dense top. The foliage and fruit show a high degree of resistance to algal spotting.

*Description of fruit.* Form oval to broadly pyriform, sometimes indistinctly grooved and surface somewhat rugose (Fig. 1); size variable, usually medium to large, weight 5 to 16 ounces, averaging 6 to 10 ounces; skin color greenish yellow to light yellow when fully ripened; flesh white, moist, fine grained, mildly aromatic, with sidewalls 1/2 inch or more in thickness; flavor mild, sub-acid; seed cavity

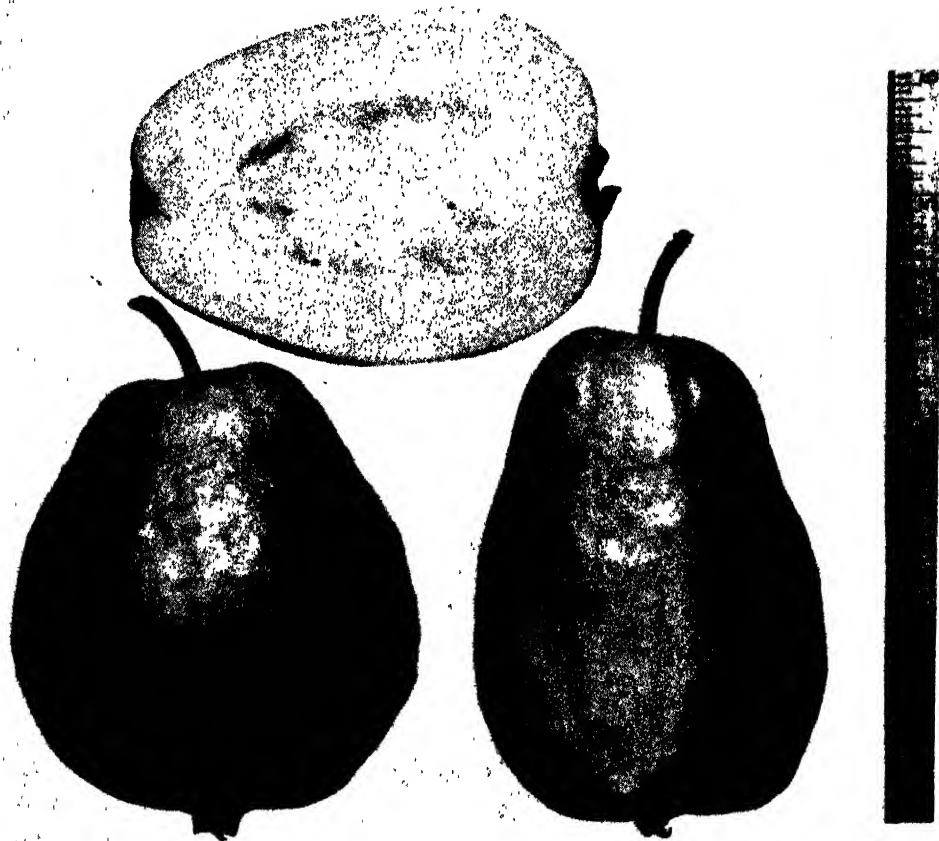


Fig. 1. Supreme guava.

small, making up 16 to 21% of the weight of the fruit, separating fairly readily from the sidewalls; seeds small and few in number for a guava; odor mild, not unpleasant; quality good.

The Supreme guava is very productive, under favorable conditions maturing some fruit over a period of about 8 months with peaks occurring in late fall and early spring. The thick sidewalls and good quality makes the Supreme a good guava for home canning and preserving and the fruit makes an acceptable jelly. The ascorbic acid content of the fruit

Inventory (4), the seed from which the Lenz tree grew was obtained from Dominica, British West Indies, and was taken from a "large Indian variety" which had been originally introduced into Dominica from India. The original Red Indian tree is growing on the Lenz property in the Redland District, Dade County, Florida, and several bearing grafted trees are growing at the Sub-Tropical Experiment Station.

*Tree.* The tree is a fairly vigorous grower forming a low-headed, spreading top. The stems of the new shoots and the veins of the

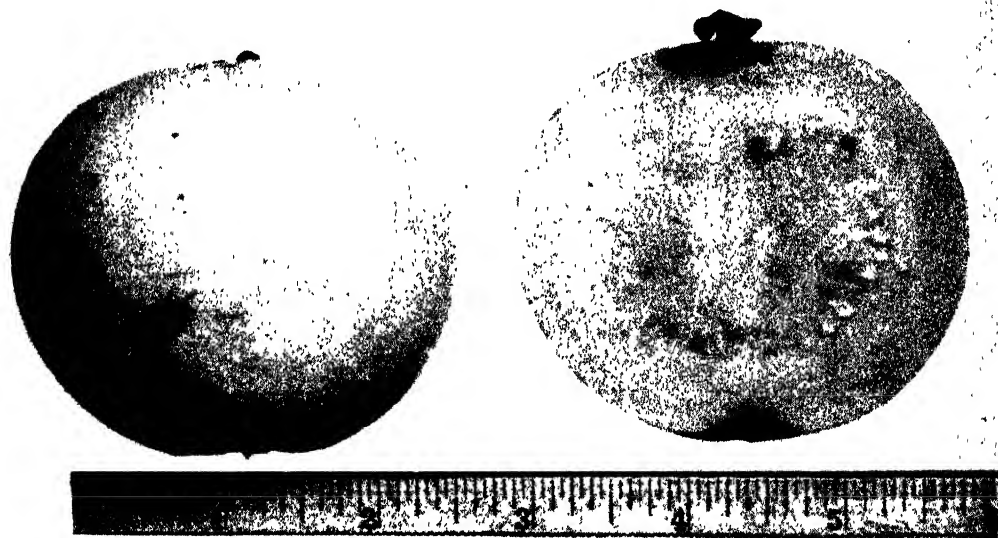


Fig. 2. Red Indian guava.

was determined by Mustard (3) to average 246.9 mg. per 100 grams of fresh fruit.

#### RED INDIAN

*Origin.* The Red Indian guava originated as a seedling obtained by Mr. Fred Lenz in 1936 from the U.S.D.A. Plant Introduction Garden at Coconut Grove, Florida, under S.P.I. number 57828. According to the S.P.I. Plant

expanding new leaves typically are reddish in color. The leaves and fruits are rather susceptible to algal spotting.

*Description of fruit.* Form globose, often slightly flattened at each end, smooth with a large open calyx (Fig. 2); size variable, usually medium to large, ranging from 3 to 12 ounces, mostly 4 to 8 ounces; skin color yellow, often with a faint pinkish blush; flesh



moist, somewhat granular, aromatic, in various shades from ruby to carmine when fully ripened, with sidewalls  $1/4$  to  $3/8$  inch thick; flavor sweet and mild; seed cavity rather large making up 30 to 40% of the weight of the fruit, not separating readily from the sidewalls; seeds numerous but rather small for a guava; odor rather strong and pungent, but fruity and not unpleasant; quality very good.

The Red Indian is primarily a dessert guava for eating out of hand as a fresh fruit. It is

Tropical Experiment Station. The latter were from a fruit produced at the Station from a seedling obtained from the U.S.D.A. Plant Introduction Garden at Coconut Grove in 1931 under S.P.I. number 81849. The original seed of this introduction came from Peru according to the S.P.I. Plant Inventory (5).

*Tree.* The tree is a fairly vigorous grower, forming a low-headed, spreading top. The stems of the new shoots and the veins of the expanding new leaves typically are pale red-



Fig. 3. Ruby guava.

quite productive, maturing its main crop in the fall and early winter months. The ascorbic acid content averages 195 mg. per 100 grams of fresh fruit (3).

#### RUBY

*Origin.* The Ruby guava is a seedling selection from seeds planted in 1937 at the Sub-

dish in color. The leaves and fruits are moderately susceptible to algal spotting.

*Description of the fruit.* Form ovate in outline, with surface slightly rugose (Fig. 3); size variable, from 4 to 10 ounces, mostly 6 to 8 ounces; skin color greenish yellow often with a faint pinkish blush; flesh moist, somewhat granular, aromatic, in various shades

from rose to ruby when fully mature, with side walls approximately 1/2 inch thick; flavor sweet and mild; seed cavity rather small making up 20 to 25% of weight of the fruit, separating fairly readily from the sidewalls; seeds relatively few; odor pungent and aromatic but fruity and pleasant; quality very good.

The Ruby is an excellent dessert guava for home use. It is good to eat out of hand and its thick sidewalls make it excellent for canning or for use as a sliced table fruit. It is a fairly heavy bearer, maturing its main crop in the fall and early winter months. The ascorbic content of this variety has not been determined.

These three selections are not the only good dessert-type guavas in Florida. We have other selections at the Experiment Station which we are studying and there are no doubt many other excellent seedlings in Florida which have not been brought to our attention. It may be advisable in the near future to hold one or more guava forums in an effort to bring to light new and better seedlings.

From the work of the late Dr. H. J. Webber in California, several named varieties of guava are now available in that state. We have grafted wood of a number of these at the Experiment Station. Thus far, those which have fruited under our conditions are scarcely equal and certainly are not superior to our own selections. Technical descriptions of the California varieties have not appeared in print to our knowledge. Three of these were recently registered as varieties with the Subtropical Fruit Committee of the California Avocado Society (6). The Riverside is described as a medium-large fruit with creamy yellow flesh and a good flavor and has a sugar content of 9.5%. This is the best of the California varieties which has fruited in Florida to date. The Rolfs is described as a medium-sized pink fleshed fruit of good quality, having a sugar content of 9%. The fruit matured under our conditions is decidedly inferior to the Red Indian, Ruby or Supreme. The Hart variety, which has not borne fruit at the Experiment Station, is de-

scribed as a relatively large fruit, light yellow in color with a sugar content of about 8%. We have made no effort to propagate the Riverside, Rolfs or Hart varieties, but propagating material is available at the Station in limited quantity to anyone interested in starting them.

Unfortunately for the establishment of guava varieties in home or commercial plantings, the common guava has proved to be difficult to propagate by ordinary methods employed with other fruits. We can graft large seedlings fairly readily, but the guava persists in suckering below the graft union. We have had no success with stem cuttings and only very limited success with various types of buds placed on young seedlings. Root cuttings are fairly successful but this is a slow way to make a large number of trees. It is our hope that some nurseryman who is skillful with the budding knife will find a way to make guava trees easily and rapidly from the good varieties. This lack of a good method of propagating is all that now stands in the way of satisfying a real demand on the part of guava enthusiasts for trees of the better varieties.

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# ORNAMENTAL TROPICAL VINES

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I feel greatly honored to appear on the program of the Krome Institute and hope you will not be disappointed that my paper does not deal with avocados or some other fruit crop, for I understand that such subjects are generally considered here.

One of the earliest impressions on my boyhood memory was of the fine lawn at the Krome home. At that time it was considered impossible to raise any sort of lawn in the Homestead section, and the dooryard in those days was alternately grown to high weeds (usually sandspurs and Spanish-needles), then cut to the bare rock and carefully swept, whereupon the exhausted owner retired to the solace of a fresh-scoured porch and his favorite cane-back rocker to await the next crop of weeds. I also recall the fine ornamental trees that Mr. Krome planted—the Sycamore Fig that is today the giant of its kind in the Redlands; the Jacaranda, the palms, the Mammee-apple, and the Lingaro. By example, he was a great influence toward making his community a better place in which to live.

Florida needs vines to soften the tropical glare on the new stucco walls to be seen everywhere; to screen the neighbors one from the other in the closely-grouped houses that literally rub elbows; and to feed the bee and the hummingbird and the mind of the child.

Since the war began, the collection of vines at the Fairchild Tropical Garden has been in my charge, and I would like to relate some of my experiences there and mention some of the more recent introductions that promise to add to the ornament of our homes and parks.

When you plant a vine you should provide for its support, pun though that may be, it is nevertheless a fact. Most vines require something

to grow on, whether it be wall, mast or chicken coop. At the Garden, many of the vines are displayed on masts, and we have been told that this is the first attempt of its kind by a botanical garden. In doing it, we are learning a lot about how best to suit this idea to the requirements of the plant and conditions that may prevail. Our first masts were poles of well-seasoned pitch pine, known as lighterwood. These decayed at the ground surprisingly fast, for the moisture and fertilizer for the vine feed the bacteria that in turn feed on cellulose, cased in resin though it may be. Lighterwood is also very brittle and may be broken by a sudden shock. We turned to sapling pine and prefer those of slow growth, as this provides the greatest strength for a given diameter. These poles were air-dried and pressure-treated, some by Celcure process (which is mainly copper sulphate) and some with zinc chromate. These soft poles take the treatment to the heart; and to aid in keeping the treating salts in the wood and leaching at a minimum, we coat the bases to above the ground with a heavy coat of asphaltum. So far this method has been very satisfactory in preventing rot, but only time will tell. No fresh creosoted timber has been used, as it exudes for a long time and might injure plants. Old telephone or electric, creosoted poles that have been in service for ten years or more may be used, and we now have some of these in service that were salvaged from the storm of last fall.

We tried tripods instead of a single pole for some of the large vines, and worked a loose network of wire around them. They make the maintenance simpler, especially the pruning and tying; but the legs must be well anchored or buried in the ground. Some of ours had the windward leg pried out of the ground in the storm. This, then, broke one or both of the other legs. I conclude that the poles should not be rigidly fastened together

at the top, but allowed to sway somewhat independent of each other.

The failure of the fat-pine framework and bamboo poles on our long pergola came even sooner than that of the masts. We have made all replacements as above.

The Combretum vines are a showy, mostly red-flowered group, headed by the great *C. grandiflorum* which Dr. Fairchild brought here from Gambia, West Africa. Its brilliant red flowers, in jet-black individual cups, are produced in dense corymbs mainly on the ends of the branches, whose leaves for a distance of a foot or more turn a rich red. This, then, is to the vines what the poinsetia is to the shrubs. It starts the show early in November and lasts till March. Woody and strong, it apparently is long-lived.

About a year ago Dr. Charles Swingle visited here and I called his attention to *Combretum coccineum*, on which a few flowers persisted, and reminded him that he had introduced it from Madagascar in 1928. He told me that he had never before seen it flower, but had brought cuttings in one of his Wardian cases on the advice of Lutheran missionaries there. This loose, woody sprawler, which attains large size, bears fine reddish flowers during March and April. The blooms are assembled in the shape of an old fashioned crumb brush inverted.

Another, with small gray-green leaves, is a tremendous grower, but not a reliable bearer. I suspect it would provide a great spring show, with a myriad of tiny bright flowers, if grown farther north, as it has done so here when denuded by frost. This vine has the tendency of producing flowers instead of leaves after defoliation.

*Combretum Smithii* is a fair grower with very small, inconspicuous pale flowers in spring. The fruit is winged, somewhat like an elm and of good size, of a brilliant light-salmon pink in great drooping sprays that do not fade for weeks.

We cultivate several other species, one of which is a tremendous, rank grower with brilliant flame-colored flowers, but so far it is a poor bloomer and is mainly good for the

mass of dark green foliage and graceful shoots.

The Combretums do not have tendrils, but run up by means of their strong growth and cling with the leaf petioles, which become blunt hooks when the leaves are shed. The Rangoon Creeper, a related plant, is similar in this respect.

The great Golden Creeper of the Malpighia family, *Stigomaphyllum periplocifolium*, deserves wider use. Likely all that prevents is the fact that it is a very slow grower when small and must be grown mainly from layers or marcottage. Something may be done by scoring the roots so they will sucker, and after a long time a few plants can be produced in this way. Some good seeds are borne, but the seedlings are timid and weak. At times our plants are literally covered with the golden-yellow lacy flowers. A real aristocrat among vines and well worth waiting for.

A few years ago the *Hiptage benghalensis* appeared here, another of the Malpighiaceæ. It is a strong-growing, woody vine which twists about anything at hand. The foliage is red in flush and a dark, handsome green when mature. The peculiar golden and white fringed and tufted flowers are generously produced twice or more each winter and none in summer. Wonderfully fragrant, they are followed by seed vessels that have three long wings. These, in turn, are highly ornamental, as the color changes through a bright pink to pale straw. I believe it will prove to be fairly hardy. Grown from seed.

Dr. Fairchild sent in from Columbia a few years ago an unnamed species of Malpighia—a small woody climber. The flowers are not outstanding, being something on the order of those on Barbados-Cherry. The seeds, however, have great wings, maple-like only much larger, that pass through several shades of light to dark red over a period of weeks. We have gotten no good seed from the first flowering here but hope to be able to offer this to our members in a short time.

Several species of *Strophanthus* have been introduced into Florida, among them the strange *S. sarmentosus* about 1928. This bears

great salver-form flowers about two inches across, mauve to lavender in color, the petals being extremely elongated, with ends drooping to below the rest of the flower. It first produced seed in this country two years ago on the estate of Col. Montgomery, founder of the Fairchild Tropical Garden. Plants and seed from that bearing were distributed to our members. The seeds are borne in a great milkweed-like pod and have a long silky pappus. They are said to be used in Africa to concoct a potent arrow poison. This I can well believe, as several species are the basis of strophanthin, a powerful heart medicine. Upon looking up this drug I found the warning that it must be used with the utmost caution. However there should be no more danger from growing this plant than there is from digitalis.

*Strophanthus gratus* with glistening leaves and flowers a wonderful rose-pink to darker, with rounded petals, is a slow grower.

*Congea tomentosa*, of the Verbenaceae family, has minute flowers almost hidden in large velvety bracts of orchid-gray color. The dense sprays almost cover the vine at flowering, in late winter, and provide much-admired material for flower arrangements, as they keep for weeks. I have not been very successful in growing this plant and have seen much better ones around. I understand that it thrives in acid soil. Difficult to propagate, and so far without seed, it will likely be a long time before it is offered generally. Some interested nursery fancier may hit on a quick way to reproduce it. I hope so.

We have an unnamed species of *Albizia* that is quite fine in late winter. This sister of the Woman's Tongue tree requires a little time to make up its mind whether to be a tree or a vine. It sprawls about and bears great heads of creamy-white flowers. The stems and twigs are very spiny, the foliage fine and feathery.

Aristolochias, or the Dutchman's-pipe, Swan-flower, etc., are always interesting, though these strange plants are sometimes objectionable because of the awful odor from the flowers of some species. *A. Braziliensis* is

one of the nicest in this respect, catering, evidently, to a more fastidious and discriminating fly. Entomologists please take note. The scent is something like citronella and not displeasing. Flowers are nearly round, about a foot across, with a beautiful pattern of dark gray to black on a mahogany background, with a brilliant shaded yellow throat. Contrary to popular belief, the aristolochias do not trap flies for food. They are held in the bulb of the flower for a time and released by the wilting or shedding of the inward-pointing hairs deep in the throat, to find their way to another flower, the chances being good that pollen will be carried along. Strange ways for strange plants.

Several species of *Arrabidaea* have been introduced. These fine members of the Bignoniaceae family have mostly velvety light-green foliage and tubular flowers, usually orchid color. The flowering period is rather brief, but they are a fine show while they last.

A tropical relative of the Silver-Thorn of the north is *Elaeagnus philippensis*, or lingaro. I saw it for the first time on Mrs. Krome's place in Homestead many years ago. How widely distributed it is I cannot state, but it deserves wide use both as a vine and shrub. The small leaves are silvery beneath, giving it an airy, delicate appearance. Strong shoots incline gracefully and one could not ask for a more pleasing subject. The greatest flowering period is usually in January, when the entire plant is filled with small pale yellow, bell-shaped blooms that give off a delicate, pleasant fragrance, one plant being enough to perfume a considerable area in the evening. The half-inch long fruits turn a frosted red and are very ornamental. They are useful for eating out of hand and for making jelly, having a sub-acid flavor. The seed must be planted almost at once, as they lose their viability very soon.

The old summertime favorite, Coral Vine, is always good. White flowered varieties are coming into use and these vary considerably, with various shadings of pink. A few years ago the Guatemalan species was introduced, having bright pink flowers several times as

large as those of the well-known *A. leptopus*.

While we may believe that the world has been pretty well scouted over for new and fascinating vines, there is no doubt that an unknown number still await the collector who may have been over the ground, but not at the opportune time. In the past, introduction was complicated by slow means of transport; while today, with the miracle of far and fast flight an everyday occurrence, seeds from the ends of the earth can reach us before they

die. Last week Mr. Jordahn showed me, on Col. Montgomery's estate, a *Mucuna*, the fabled d'Albertis creeper of the South Pacific, now coming into flower for the first time away from its home. A soybean relative with red flowers, said to compare in beauty with the *Amherstia nobilis*.

Who knows when another plant will come to light that will mean as much to this state as the flame-vine has meant.

## PROMISING NEW PALM INTRODUCTIONS

A. C. JORDAHN

*Fairchild Tropical Garden and  
Coconut Grove Palmetum  
Coconut Grove*

From the excellent bulletin No. 84 of the University of Florida Agricultural Extension Service, 1936, by Harold Mowry, which fully describes all of our native and numerous introduced palms, I quote from his introductory remarks:

"There are without doubt numerous species of palms which, if introduced, would thrive in some sections of the state, and no opportunity should be lost in giving new species a fair trial."

With this thought in mind, I trust that these notes based on actual experience in testing and growing palms will be of some interest to the members of this Society.

Introducing and testing new plants has interested many people since the warmer parts of the state were first settled, and horticulture in Florida owes a lot to these early settlers who brought material from far and near. The Reasoner Brothers of Oneco should be especially commended as they were instrumental in introducing a lot of good plants, among which were palms which now are to be found all over the state.

The U. S. Plant Introduction Garden carries this work right along and has an exten-

sive collection. As this has been developing for a number of years it contains a large number of splendid specimens and amply repays a visit by anyone interested in palms as well as other tropical plants.

In 1932 Col. Robert H. Montgomery decided to locate in the Miami area and acquired a large tract of land with the avowed purpose of trying to establish and grow as many species of palms as would find conditions here suitable. He acquired the support of some of the most eminent horticulturists of the country and the cooperation of the U. S. Department of Agriculture, also the various botanical gardens and botanists in the tropical part of the world from which numerous seeds were obtained and planted. Dr. Fairchild made several collecting trips and paid especial attention to new palms. At the present time a total of 2500 lots of seed have been received and planted, at the Montgomery estate and at the Fairchild Garden.

Naturally many of these introductions have not been a success, but considering the varied conditions of temperature, moisture and soil in the countries where the seeds have been collected, it is on the whole rather surprising that so very many should find tolerable our not altogether favorable growing conditions.

Having experienced a serious deficiency in the rainfall for the past few years, one

hard freeze in 1940 and a full size hurricane in 1945, the newer introduced species which still thrive in spite of these hazards may well be considered sufficiently tested to warrant further planting. They have not only been proven hardy enough to succeed here but also possess such characteristics as to make them desirable for more general planting, and I may add that some species have produced seeds here and plants have been distributed by the Fairchild Garden to its supporting members. Many others still in the nursery give promise of doing equally well and will no doubt also be found satisfactory when given a chance to develop.

For those of you who will visit the Fairchild Tropical Garden for the first time, it consists of a collection of palms planted on the site of an old fruit grove which contains some of the first plantings of named varieties of mango in the United States. This palm collection now numbers in excess of 350 species and varieties and is becoming more and more interesting. Another large section contains related groups of trees and shrubs, fronted by a collection of vines. The Garden has progressed since its establishment in 1938 and, now that labor conditions are improved, can go ahead with its extensive plans for improvements. Colonel and Mrs. Robert Montgomery gave the land for the Garden, named to honor Dr. David Fairchild.

I shall now enumerate some of our newer successes in the palm families:

*Acrocomia crispa*. Cuba. This striking palm with a very distinct bulge in its trunk has pinnate leaves. It is a very slow grower in its young state but when thoroughly established it makes a rapid growth. In common with other species of this genus it is very thorny. It is well suited as a specimen plant and will certainly command attention.

*Arenga mindorensis*. East Indies. Unlike the sugar palm, *A. saccharifera*, which has a single trunk, this species is suckering and forms a large clump. A splendid specimen noted a few years ago in the Homestead area had a height of 10 ft. and a diameter

of fully 15 ft. Its numerous graceful pinnate leaves made it a striking object. It thrives well on high land and makes fairly rapid growth.

*Borassus fabellifer*. India and Ceylon. The Palmyra palm is of enormous economic importance in its native habitat. Every part of it is used, trunk, leaves, fruits, flowers, and even the germinating root of the young seedlings. Its mode of germinating by sending down a "sinker" to a considerable depth makes it preferable to plant the seed where the palm is wanted and tend it with needed watering. It has a stout trunk with large palmate leaves, and eventually it reaches large size.

*Chamaedorea* spp. Several of these dwarf-growing palms have succeeded very well. Being shade loving they are nicely adapted for patio work and for planting in shady corners around buildings. A fine species as yet unidentified from Honduras forms a clump of canes about  $\frac{1}{2}$  inch in diameter, clothed with numerous pinnate leaves. Height about 8 feet.

*Copernicia Cerifera*. This is one of the palms which produce carnauba wax. It seems to thrive easily but is of slow growth. *C. Baillyana*, on the other hand, is a fairly rapid grower. Even in a young state it is a very attractive palmate leaved palm which eventually will reach a large size.

*Corypha elata*. Burma. This large-growing, fan-leaved palm thrives excellently in our low land, where it is making a rapid growth.

*C. umbraculifera*, the famous Talipot palm, appears to be rather tender for this locality. This palm is noted for its characteristic of flowering but once upon reaching maturity. It produces a flower cluster of enormous size, and after the plant has performed the function of reproducing itself, it dies. In the tropics this is a matter of about 30 years, but from the rate of growth of our palms here, I imagine it will take very much longer.

*Guilhelma utilis*. Brazil. This is not an especially attractive palm. Its chief interest consists in its rather dry but edible fruits

which are of economic value in its home, where it is known as a peach palm.

*Hyphacne thebaica*. Egypt. This is succeeding well here. Its long petioles have stout spines and the palmate leaves are of a gray-green color. The fleshy part of the fruit is supposed to resemble gingerbread in color and taste, hence it is known as the Gingerbread palm. The specimens here have fruited several years. So far no one has found them palatable. It is, however, a noble palm and of a great deal of interest, as it is one of the very few palms of distinctly branching habit.

*Livistona decipiens*. Indo China. This is of much more rapid growth than the commonly grown *L. chinensis* and is clothed with considerably more foliage, of finer texture. It and *L. mariae*, of Australia, are both well worth growing.

*Mcdimia nobilis*. Madagascar. A robust-growing palm with immense palmate leaves and a heavy trunk. A striking looking plant, as yet very rare since the seeds apparently are difficult to procure.

*Nipa fruticans*. India. The Nipa palm is at home in the tidal flats, where it covers miles of territory, and is of great economic value.

It spreads slowly by underground stems and seems right at home in lowlands here subject to tidal overflow.

*Phytelphas macrocarpa*. South America. This palm produces the ivory nut of commerce. While it is of slow growth, it makes a fine specimen in time, which also applies to *Polyandrococcus caudescens*. South America. Both of these palms are described as very handsome and certainly warrant wider planting.

*Scheelea leandroana*. South America. One of our good palms. It has a short stout trunk and a crown of immense pinnate leaves 20 ft. long. Resembles *Attalea* in growth but is less formal in appearance.

*Trithrinax acanthocoma*. Brazil. These palms grow under rather dry conditions, so are adapted to our high land.

*Veitchia johannis*. Fiji Islands. While rather slender, this tall pinnate-leaved palm makes attractive specimens. It has produced viable seeds here.

*Wallachia caryotoides*. India. A most attractive clump palm. As its name implies, the foliage resembles the better known fish-tail palm.



# SYMPTOMS EXHIBITED BY AVOCADO TREES GROWN IN OUTDOOR SAND CULTURES DEPRIVED OF VARIOUS MINERAL NUTRIENTS

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A knowledge of the symptoms of malnutrition exhibited by plants supplied nutrient solutions that were complete except for a single element has been found helpful in diagnosing nutritional troubles that appear in plants in the field. Although the responses of plants in general to severe deficiencies of the known essential mineral elements tend to follow established patterns, there are sufficient differences in the expression of deficiency symptoms by different species to make it desirable to establish as completely as possible the responses peculiar to each of the important economic plants. Our knowledge of the responses of the avocado to mineral deficiencies is meager.

Haas (2) has reported the symptoms characteristic of potassium, phosphorus, manganese, and boron deficiency exhibited by avocado seedlings grown in solution culture in the greenhouse in California. Zinc deficiency symptoms in the avocado as they appear in the field have been described by Parker (4) in California and by Ruehle (5) in Florida. Ruehle and Lynch (6) have reported that avocado "dieback", was corrected by copper sulfate, though they suspected that the symptoms of this disease may have involved more than copper deficiency alone.

Two varieties of avocado, Taylor and Lula, were used in the present investigation. The yearling trees were removed from boxes of soil in which the seedling rootstocks had been grafted, washed, and planted in 8-gallon crocks of washed white sand (St. Lucie sub-

soil). The Taylor trees were maintained in the sand cultures for over two years; the Lula trees for about 18 months. One set of Taylor cultures (8 trees) was supplied with the following nutrient solutions: complete, minus phosphorus, minus potassium, minus magnesium, minus manganese, minus boron, minus zinc, minus iron. Duplicate sets of Lula cultures (total of 20 trees) were supplied the same solutions as the Taylor trees and, in addition, minus copper and low nitrogen solutions. The complete nutrient solution used was Hoagland's (3), and in the solutions lacking one element suitable substitutions were made. Fresh nutrient solution was added in varying amounts and at intervals varying from weekly to daily, depending upon size of tree, upon season, and primarily upon the rate at which the pH of the solution in the culture vessel changed. The cultures were flushed out before each addition of nutrient solution, usually with rain water, but when this was not available, with tap water. The pH of the flushed leachate, which was not re-used, varied from about 3.6 to about 6.5.

## DEFICIENCY SYMPTOMS

It is not certain that all of the symptoms of malnutrition displayed by the trees described here are characteristic of specific deficiencies. Until the results described below are confirmed by more extensive work, they should be considered as tentative. In the main, however, the symptoms of malnutrition described here are similar to those that have been established by extensive work on other plants. The symptoms displayed by the two varieties, Taylor and Lula, were practically identical, but because the Taylor cultures were maintained for a longer period than the Lula cultures and showed more pronounced symptoms, most of



Plate 1. Taylor avocado trees grown in sand cultures supplied with the following nutrient solutions; No. 11, complete; No. 12, minus magnesium; No. 13, minus zinc; No. 14, minus manganese.

the illustrations are of the variety Taylor.

*Nitrogen.* The trees grown in the low nitrogen cultures were badly stunted, the bark was reddish brown, and the spring-flush shoots short and thin. The immature leaves on elongating shoots were amber to an abnormally bright red color. The mature leaves were very small, stiff, and yellowish green. In summer and fall the old spring-flush leaves gradually burned from the tip toward the base and finally were abscised when nearly all of the blade had burned. The appearance of Lula leaves from the complete and low nitrogen cultures is shown in plate 3, J and K.

*Phosphorus.* The general appearance of a Taylor tree that was suffering severe phosphorus deficiency is shown in plate 2, No. 15, and that of a single leaf in plate 3 E. The tree was stunted, and the number of leaves on the plant was greatly reduced as a result of abscission of the older leaves. The leaves were smaller than normal and distinctly rounded. The leaf blades were stiff and leathery. Soon after reaching maturity the leaves became dull brownish green in color. This bronzing, or change of color to dull brownish green, was the most distinctive symptom of phosphorus deficiency observed. Many of the twigs lost all of their leaves and died back to larger branches. Some of the leaves, as they aged, burned at the tips and margins. When the cultures were dismantled, it was found that the phosphorus-deficient trees were making almost no new root growth, and the old roots, though alive, were black rather than the normal light brown in color. While the root systems in most of the cultures showed signs of malnutrition, only those of the phosphorus-deficient plants displayed symptoms that were distinctive.

*Potassium.* The first symptom of deficiency observed in cultures lacking potassium was the development of somewhat narrowed leaves of slightly subnormal size. Soon after the leaves reached maturity, they became very deep green. Later the intensity of green color decreased. By late summer the leaves of the spring flush showed numerous small, light-brown specks scattered over the leaf. As the

leaves aged, the brown specks coalesced into large, irregular, reddish-brown areas of dead tissue between the large veins, along the margins, or at the tip (plate 3 F). The trees were badly stunted, and on severely deficient trees the twigs were very thin and some of them died back during the winter (plate 2, No. 16).

*Magnesium.* No symptoms of deficiency were observed during the first season of growth in the cultures lacking magnesium. The trees were as large as those receiving complete nutrient solution (plate 1, No. 12). By midsummer of the second season the Taylor tree deprived of magnesium was making less vigorous growth than the control, and the leaves were a lighter green. By September the leaves were greenish yellow over the entire area of the leaf except for a slightly deeper green along the midrib and large veins. In late fall and winter the leaves became yellow, and small, brown, dead lesions appeared scattered over the entire leaf blade. The appearance of a magnesium-deficient leaf is shown in plate 3 B. Magnesium deficiency symptoms did not appear on the Lula trees. This would suggest that, in the avocado, magnesium must become very low before the leaves show obvious deficiency symptoms.

*Manganese.* Immature leaves did not show symptoms of manganese deficiency, but as soon as the leaves matured, many of them developed yellow areas between the veins. These interveinal yellow areas were at first almost separate from each other, and at a glance appeared as two rows of yellow spots running parallel to the midrib. With aging of the leaves, the yellow areas coalesced somewhat, though the area along the larger veins remained green. The appearance of a leaf in an advanced stage of manganese deficiency is shown in plate 3 D. There was no apparent dwarfing of the tree or leaves. The manganese-deficient Taylor tree is shown in plate 1, No. 14.

*Zinc.* No symptoms of malnutrition appeared in the Lula cultures, and no sign of malnutrition appeared until midsummer of the second season in the Taylor culture. Then a few leaves showed slight mottling. By September



Plate 2. Taylor avocado trees grown in sand cultures supplied with the following nutrient solutions: No. 15, minus phosphorus; No. 16, minus potassium; No. 17, minus boron; No. 18, minus iron.

pronounced yellowing between the veins had developed on many of the leaves. Parker (4) described the initial symptoms of zinc deficiency in the avocado as yellow areas between the veins. The pattern of yellowing on the Taylor tree was more diffuse than the pattern that is typical of zinc deficiency in citrus. The leaves were normal in size (plate 3 C) and never developed the recurved midrib and trough-shaped leaves described by Ruehle (5) as typical of leaves suffering severe zinc deficiency. The trees in the minus-zinc cultures attained normal size (plate 1, No. 13).

Possibly the symptoms of malnutrition observed on the Taylor tree represent the early stages of zinc deficiency, but the characteristics described above lead us to believe that probably they resulted from some other disorder.

*Iron.* The first visible sign of iron deficiency was the appearance of leaves with yellowish-green color between the veins and narrow areas of darker green along the veins. These leaves were of the spring flush. The summer-flush leaves were reduced in size, with blades thin and delicate, and when immature they were a very pale yellow, or almost white, with little or no difference in color between the areas along the veins and those between the veins. As these leaves matured, the areas along the veins became green. In late summer and fall the most severely chlorotic leaves began to burn at the tips and along the margins. The early stage of leaf burn on a chlorotic leaf is shown in plate 3 G. On some shoots all of the leaves burned badly. By late fall these shoots were defoliated and dying back from the tips (plate 2, No. 18).

*Boron.* The spring flush of growth of the trees in the cultures deprived of boron was not quite so vigorous as that of the controls. The internodes were slightly shortened and, as compared with the controls, there was a slight increase in the number of lateral shoots produced. The leaves were not quite so dark green as those of the controls, and some leaves were slightly dwarfed. In the summer flush of growth striking signs of boron deficiency ap-

peared. The new shoots were very short, and the leaves at the tips of these shoots were greatly reduced in size and were yellowish green in color. Some time after reaching maturity, many of the leaves burned at the tips and margins and finally were prematurely abscised. The internodes near the tips of these partly defoliated shoots were much shortened and the axillary buds were greatly swollen, giving the shoots a knobby appearance. Typical shoots of Taylor and Lula from control and from boron-deficient cultures are represented in plate 4. By fall the bud scales, which were enlarged, had burned at the tips, and some of the terminal buds were dead. The abscission of leaves progressed from tip to base of shoots, and some shoots died back several inches from the tips. After the short new terminals lost their leaves, some of the axillary buds grew into extremely short shoots with small, yellow, scale-like leaves that soon burned and died. During the first season of boron deficiency there was little dwarfing effect, but by the end of the second season the Taylor tree was appreciably stunted (plate 2, No. 17).

*Copper.* The cultures deprived of copper developed, during the growing season of 1945, very dark green foliage and slightly S-shaped shoots. Camp and Fudge (1) state that in citrus the first sign of approaching copper deficiency is 'the development of unusually dark green foliage and the production of S-shaped shoots. Ruehle and Lynch (6), in describing symptoms of severe copper deficiency that appeared in young avocado trees in the field, presented photographs of trees that had S-shaped shoots, though they did not specifically state that this is a characteristic symptom of copper deficiency in the avocado.

Since the copper-deficient cultures apparently received enough copper, supposedly from impurities in the chemicals, water or sand, or from some other source, to prevent the appearance of symptoms of severe deficiency, it is uncertain whether the development of dark green leaves and the slight tendency to produce S-shaped shoots observed here should be

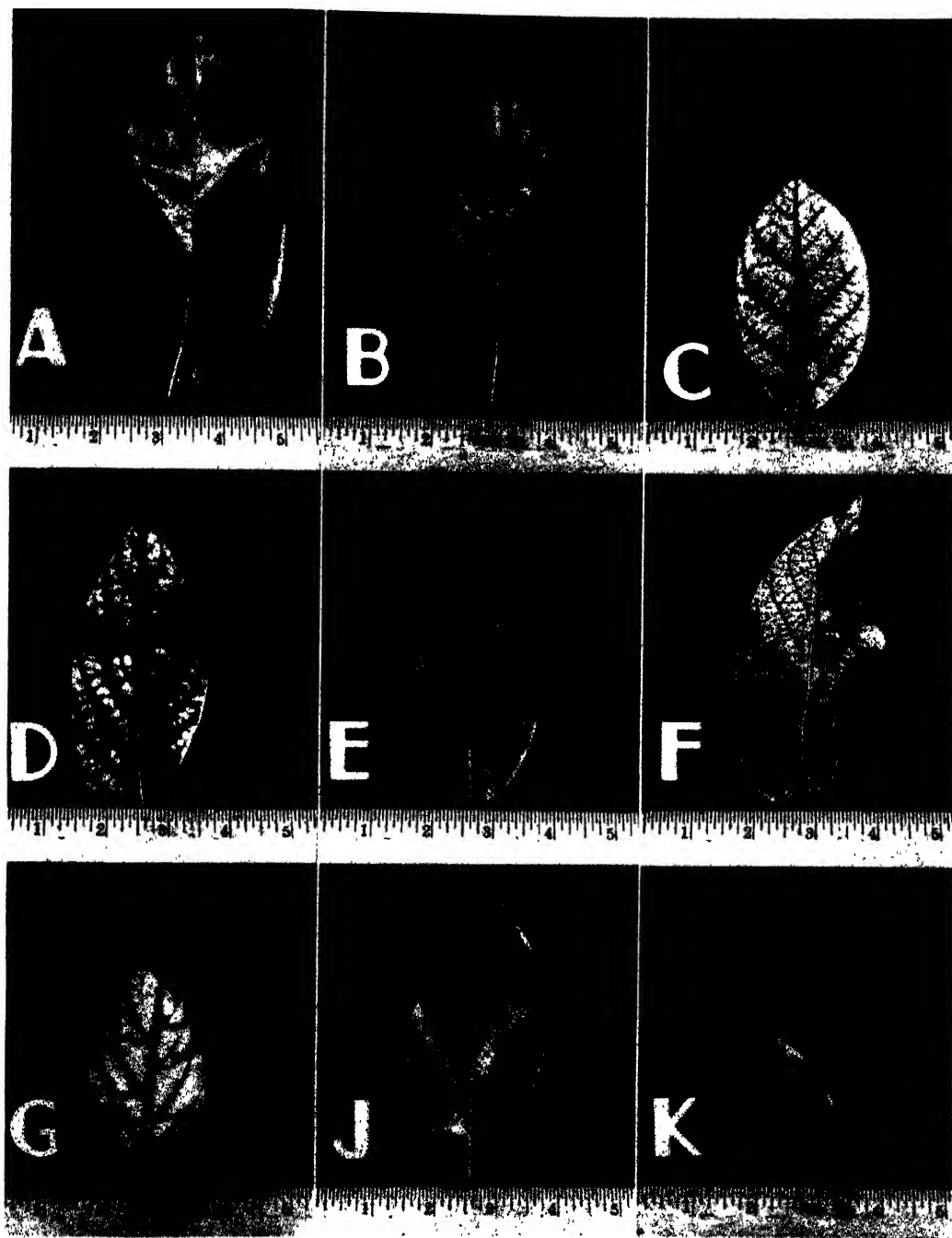


Plate 3. Taylor avocado leaves from plants grown in sand cultures and supplied with the following solutions: A, complete; B, minus magnesium; C, minus zinc; D, minus manganese; E, minus phosphorus; F, minus potassium; G, minus iron; J, Lula avocado, complete; K, low nitrogen.

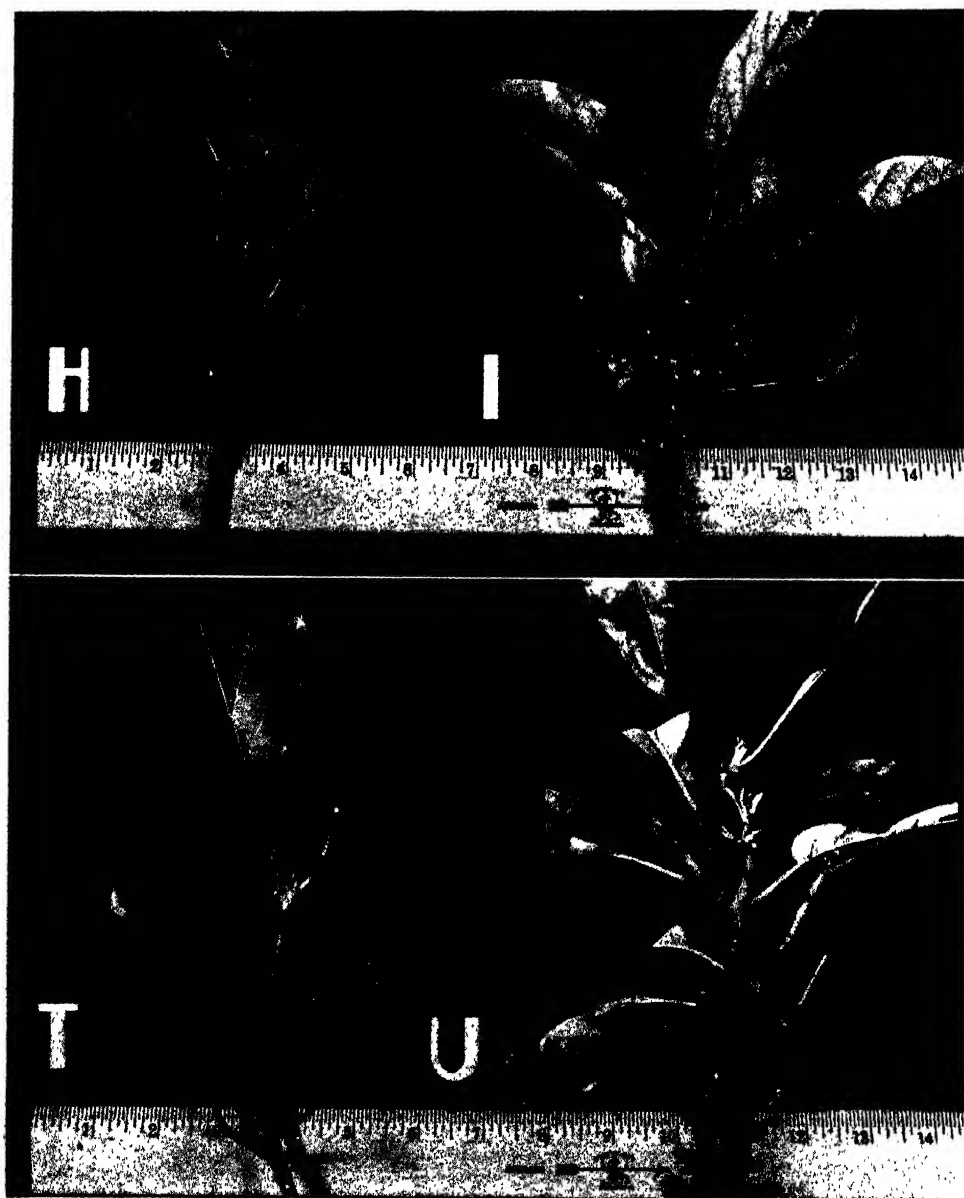


Plate 4. Taylor and Lula avocado shoots from complete and minus-boron cultures; H, Taylor, complete; I, Taylor, minus boron; T, Lula, complete; U, Lula, minus boron.

considered characteristic early symptoms of copper deficiency in the avocado.

Ruehle and Lynch (6) described the development of a severe multiple bud condition and dieback of the shoots of their copper-deficient avocado trees. Their photographs showing this condition bear at least a superficial resemblance to our illustration of boron deficiency. Therefore, under field conditions, it may be difficult to distinguish between multiple buds and dieback caused by a deficiency of copper and the condition caused by a deficiency of boron, and caution should be exercised in diagnosing these deficiencies without additional criteria.

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## THE INHIBITING EFFECT OF THE TERMINAL BUD ON FLOWER FORMATION IN THE AUXILIARY BUDS OF THE HADEN MANGO (*Mangifera indica* L.)

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#### SUMMARY

Inflorescences in the mango are determinate and appear under normal conditions only from terminal buds. If, however, the terminal buds are removed during the flowering period, in-

florescences are produced by axillary buds in the distal region of the shoot. Normally the axillary buds remain dormant during this period, but later some of them produce vegetative shoots. Results of experiments on girdled, decapitated branches which were defoliated at various intervals after the removal of the terminal bud indicate that when leaves were present above the girdle floral induction took place in the axillary buds in a period between one and four days after decapitation and that floral differentiation rapidly followed.

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# HURRICANE DAMAGE TO TROPICAL PLANTS

H. F. LOOMIS

U. S. Plant Introduction Garden

Coconut Grove

On Sept. 15, 1945 a rather small but severe hurricane entered Florida in the southern part of Dade County and crossed it in a northwesterly direction. The "eye" or calm center of the storm probably was not over ten miles in diameter and passed between Homestead and Perrine, but hurricane winds were felt for a number of miles south of Homestead and to the northern part of Miami. Thus practically the entire area of truck gardening and of commercial mango, avocado and citrus growing in the county was exposed to the storm and suffered extensive damage, as did nearly all other plantings, and there was considerable structural loss as well.

Since the climate of south Florida permits, an immense number of tropical and subtropical plants already have been introduced here until no other part of the United States can boast so large or diversified a flora of exotic plants, but still the tropics of both hemispheres offer many times as many plants as have been established here. Unquestionably the beauty, appealing peculiarities and commercial prospects of these plants, in combination with the climate, have attracted an ever-increasing number of permanent residents and temporary visitors from the north. The behavior of these plants under all conditions of soil, weather and treatment, are, therefore, matters of great importance to practically every resident in the region. Repeated tests have shown that certain desirable tropical plants cannot be grown here for one reason or another. Moderate winter cold prevents growing the breadfruit, mangosteen, giant Victoria pond lily, and the beautiful seacoast tree *Barringtonia speciosa*. Summer heat prevents growing of the Hawaiian hibiscus relative,

*Kokia rockii*, which is native where temperatures are moderate and fluctuate little. Acid-soil plants are ruled out of most of our locations except where special treatments are given to acidify the soil. Many plants, native of dense jungles or places where severe winds do not occur, are affected by constant trade winds and badly broken by severe storm winds. Following the passage of the September hurricane the effects of various storm factors on plants could be seen throughout the region.

At the U. S. Plant Introduction Garden, 6½ miles south of Coconut Grove, several thousand species of introduced plants are growing in the scant soil on the oolitic limestone rock that is typical of the southern part of the county, and in the coastal lowland marl as well. The center of the hurricane passed only a few miles to the south, consequently the Garden was for a time in the northern, right-hand quadrant of the hurricane where the advancing speed of the storm was added to the speed of the wind and maximum wind velocities were attained. It has been estimated that at the height of the storm, velocities of at least 135 miles per hour were experienced. The wind blew from the east, swinging to the southeast and south, as the center of the storm passed. The tide rose and sea water covered the lower part of the Garden to a depth of 6 or 7 feet. Rainfall, during the 24-hour period in which the storm occurred, amounted to 6.75 inches.

At this Garden, as elsewhere, the greatest and most direct effect of the wind naturally was the breakage of limbs, uprooting of trees, and defoliation of a host of dicotyledonous plants. From previous storm experience it was known that *Pithecellobium dulce* and the Australian *Acacia auriculaeformis*, both shallow-rooted trees used extensively in the past for street planting, were easily uprooted. This fact was again demonstrated, for many of these trees were overturned and those that stood

were severely broken. The handsome dark green, dense foliaged *Casuarina lepidophloia*, used in many Garden locations as a windbreak, and one of the trees that held its leaves, was an early victim of the storm, for practically every tree was blown down by the wind that came from the east as the storm approached. Trees of *Casuarina equisetifolia*, taller but of more open character and planted in windbreaks on the low land where the water table was about 3 feet below the surface, also were uprooted or broken off, almost without exception, and other species of the same genus, planted in smaller numbers, suffered the same fate. These two windbreak species, in falling, did extreme damage to plantings they were supposed to protect, and a tremendous amount of labor was expended in their removal and in restoration of plants they had crushed. *Melaleuca leucadendron*, extensively planted on the same low ground, withstood the storm fairly well with some breakage of limbs but almost no uprooting in spite of its failure to lose its leaves. *Ficus* species, which tended to hold their leaves, were overturned in many locations, especially where planted in shallow holes or on the low land where the water table prevented deep rooting. Trees of *Ficus nitida* and *F. benjamina* in such locations were outstanding victims in spite of numerous supporting trunks developed from aerial roots. The African mahogany tree, *Khaya nyasica*, that in other respects appeared well adapted to the region and offered commercial possibilities for cabinetwood, was planted in a number of locations at this Garden and a large planting had been under observation in recent years at the Sub-Tropical Experiment Station at Homestead. Scarcely one of these trees remained standing after the storm. The related Cuban cedar, *Cedrela odorata*, planted in smaller numbers at the Garden, suffered a similar fate. Members of the genus *Swietenia*, including the native *S. mahagoni*, fared better, with no uprooting, although breakage of limbs caused some damage. Breakage of limbs of avocado and mango trees was severe and where these trees were planted in shallow

holes on the rock, overturning was common; even in deep soil areas the heavy rain so softened the earth that the constant buffeting of the wind caused a few trees to go down. This effect of the rain undoubtedly hastened the uprooting of many trees that probably would have fallen even had there been little or no rain, but trees that otherwise might have survived, like *Terminalia arjuna* and *Bucida bucceras*, had their long roots pulled through the sodden earth and thus fell.

A great many trees and shrubs that were not blown down nevertheless were bent over badly and suffered considerable damage to their root systems and still more when they were returned to an upright position after the storm. As a consequence of plants being blown down, inclined or having branches badly broken or defoliated, shaded parts of the trees were exposed to full sunlight and there was considerable scalding of bark on trunks and limbs of many trees before they could be set up or before new leaves gave them protection.

A factor that contributes tremendously to plant damage in hurricanes is the veering of the wind as the storm progresses. This shifting of the wind is increasingly pronounced as the center of a storm is neared and is most extreme where the center passes over any given point, for here the wind blows from one direction as the center approaches and suddenly changes to the opposite direction as the center passes. Thus plants are buffeted in different directions and the resulting loosening and breaking of roots and branches is increased.

Prompt defoliation in a storm contributes immeasurably to a tree or shrub's chances of survival, for bare branches offer little resistance to the wind. Loss of leaves is a temporary matter and, with satisfactory conditions following a storm, new leaves seldom are long in appearing, and complete recovery from storm effects may be rapid. An unexpected example of early defoliation and the protection it offers was the very tropical appearing member of the *Araliaceae*, locally known as the

Australian Umbrella-tree, *Schefflera actinophylla*. This tall, many-stemmed, soft-wooded plant lost practically every leaf and thus was reefed down to bare poles that bore the full brunt of the storm with little other damage, and after the storm new leaves were quickly produced and today the plants show little evidence of the ordeal they weathered.

Another outstanding plant that gains protection through loss of leaves is the Royal Palm. In a severe storm, such as that in September, the Royal Palms lose their leaves as the fury of the gale increases until only the tightly wrapped heart leaves remain, and in this condition the palms usually survive the storm. Since the species of Royal Palms are native in Florida and the Greater and Lesser Antilles, where hurricanes are of almost annual occurrence, their survival may, in part at least, be attributed to this characteristic which few other palms have in the same degree.

With trees that fail to lose their leaves, much damage is done to the smaller branches and to the foliage by the whipping, tearing and bruising by the wind, and often salt spray is charged with contributing to the injury and may account for some of it, especially where the sea is nearby, and salt concentration in the spray and wind-driven rain is high. Generally speaking, foliage damage from any cause in one of these storms, while making plants unsightly for a while, seldom seems to have a lasting effect on most plants, as new leaves usually are produced in a few weeks.

On some trees, however, notably those from jungle environments, not only is there severe leaf injury, but the beating of the wind on slender stems and branches may completely wear away the bark and cause the death of these parts. The African rubber-producing tree *Funtumia elastica* was a striking example of this, and after the storm the white inner wood of the small branches was exposed in remarkable contrast to the larger branches, where the dark brown bark still remained. The Para rubber-tree, *Hevea brasiliensis*, also suffered in this way and, having brittle wood

was rather badly broken, but there was no overturning of trees since the species is anchored by an exceedingly sturdy tap-root.

In the lower part of the Garden that was flooded by the sea, damage directly due to salt poisoning was evident in surprisingly few cases. Here were a large majority of trees, shrubs, vines, palms, and bamboo species represented elsewhere in the Garden. These species were completely covered or had salt water at their bases probably for several hours. The soil in this area consists of marl that was pumped from the mangrove swamp in the first World War to form a flying field. This marl takes up water slowly and probably had become nearly saturated with rain before the sea rose and hence absorbed little salt water about the roots of plants. Plant losses directly attributed to salt water flooding were lychees, a few small bamboo plants that were completely covered, and mature specimens of the following palm species: *Butia capitata* and *B. bonneti*, *Martinezia corallina* (referred by Burrett to *Aiphanes minima*), *Dictyosperma alba* and *Attalea spectabilis*. Several species of *Caryota* were injured but there were many species of palms, some so small or young that they were entirely flooded, that showed no effects of the salt water.

As a class the palms, aside from those affected by salt water flooding, and the bamboos at the Garden and elsewhere in the storm area withstood the storm better than dicotyledonous plants. Practically no palms were overturned, as it would seem that their dense mass of fibrous roots so firmly anchored them that the force of the storm, even aided by the moistening of the soil by rain or flooding, was not sufficient to uproot them. A considerable number of coconuts and old Royal Palms were broken off at ground level where the trunks were constricted at the root-crown but this did not happen to other palms, and very tall specimens of *Washingtonia* and *Livistona* were standing almost unscathed after the storm. Several immense *Borassus* palms were uninjured although one was slightly forced over.

In the collection of bamboos practically

every specimen planted in a suitable location survived with little breakage of canes or loss of leaves. A number of dense clusters of the spiny bamboo, *Bambusa arundinacea*, from seventy to a hundred feet high and planted in less than a foot of soil on the top of a crushed rock ramp of the old airfield, were overturned but, when they were severely pruned back, the mats of roots and stumps fell back into position and new shoots soon were pushing up.

While almost no plants in the Plant Introduction Garden escaped some injury, the fact that specimens of most species had been planted in several locations, on the high pine land as well as on the lower filled area, usually resulted in the survival of at least one representative of a species and relatively few introduced species were completely lost as a result of the storm.

Following the observations made on this storm, it seems that some precautions that will

minimize losses can be taken in the future. It appears that there are no trees that can be recommended for windbreaks that will give the desired protection under normal weather conditions and will also withstand hurricane winds. Planting of large, shallow-rooted trees, that are known to be susceptible to uprooting, should be avoided except where their fall will not damage buildings or other plants. Trees that attain large size should not be planted on land where the water table is so close to the surface that deep rooting is restricted, as such trees are too easily overturned. Planting in shallow soil or in blasted holes that are too small for the plants when mature is also a dangerous practice and does not give optimum conditions, even under normal circumstances. Actually, however, the best advice that can be given regarding precautions against a hurricane is to avoid it completely.

## HURRICANE DAMAGE TO COMMERCIAL FRUIT TREES IN DADE COUNTY

J. R. BROOKS  
Homestead

The hurricane of September 15, 1945, as you know, had a top wind velocity of 150 to 160 MPH. The path of greatest destruction was only 40 miles wide running from the town of South Miami to slightly south of Florida City. The lowest barometer reading was 28.09 at the Army Air Base. This area embraces 75 to 90% of the production of avocados, limes and mangos in the state. Winds of hurricane force lasted approximately four hours, the lull lasting between 45 and 50 minutes.

This paper deals mainly with damage to avocados, limes and mangos.

*Damage to Avocados:* The damage to avocados varied greatly depending upon size and height of trees, and to a lesser degree on variety and condition of the tree at the time

of hurricane. There seems to be some little difference in ultimate damage between a grove which was encircled with an Australian-pine windbreak or other type of windbreak, and those not having any windbreak. The windbreaks did some good while the wind was 90 to 100 miles but when the wind reached a higher velocity than this the windbreak was blown over on to the fruit trees, causing more damage than the wind itself. Trees that were high and very large blew down quickly and suffered more damage than those that were not as tall. There was some difference between varieties but this was due mainly to the type of growth that these varieties have; that is, if they are short, low-headed trees rather than tall, slender ones. It seems to me there was one variety which suffered considerably less damage than other varieties and that is the Collinson. They seemed to stand up better than

other varieties of the same age and height. (However, we do not recommend propagating Collinsons for several other reasons.) Generally, West Indian varieties are recovering much slower than either Hybrid or Guatemalan, one outstanding exception being the Pollock, which recovered very quickly. Trapp is coming back very slowly, some dying. Of the Guatemalans, the Taylor is making the quickest recovery.

Damage to avocados can be classed roughly into three types—root damage, bark damage and breakage of limbs and foliage. Root damage was severe to both the trees that went over and trees that were not blown over. In the case of trees that were not blown over, any number of them are dying back. In the case of bark damage, this was mainly caused by sunburn before the trees could be put up, which in some groves was very severe. It was also caused by twisting of the limbs and trunk resulting in breaking and damage of the cambium layer. The third type of damage mentioned was caused by the force of the wind breaking the limbs, in some cases limbs as large as 10 and 12 inches in diameter; also breakage resulting from the tree falling on the ground.

In setting trees up after the storm, the tops were cut back to leave a surface equal to or slightly more than the estimated good roots. Some growers cut their trees back to within 3 or 4 feet from the ground; other growers did not cut their trees back at all; but the most prevalent method used was that of cutting the top back equal to the remaining root system, and at the present writing this appears to have been the better way, although at present writing it is really too early to tell which will prove to be the better method. Incidentally, it is still too early to evaluate the total damage to trees. The props that we used were saplings cut from the woods, 2x4 lumber, or 1x6 slabs. Two to three props were used per tree.

There were various kinds of fertilizer used, such as 4-9-3, 4-8-6, 4-7-5 and 5-7-5. Most of the fertilizer used did not contain any of the

minor elements, such as magnesium, manganese, etc. The best results seem to have been obtained from 4-7-5 or 5-7-5 mixtures containing 1% to 2% magnesium. Poundage varied from one-third application to a full application, and while a full application unquestionably wastes some fertilizer it seems to have gotten a little quicker response. Wherever possible a mixed fertilizer having an organic nitrogen content of 20% to 40% was applied with a mechanical spreader.

Some growers used a tractor with rope or cable to pull up trees. Before pulling the tree up the dirt was dug out from under the roots so that the tree could again set approximately vertical. The dirt was then put around the roots either by hand or with the use of a small bulldozer.

The approximate cost of raising the trees, fertilizing, putting dirt on the roots, pruning and hauling all of the dead wood out, varied greatly depending upon the size of the grove and the amount of damage in the grove. On the average, the cost of setting large trees 12 years old and older varied from \$40 to \$140 per acre, one of the greatest single expenses being the cost of hauling out all brush, etc.

Some fruit was salvaged from practically all groves. This fruit averaged from \$1.75 to \$3.50 per tomato field box delivered to the packing house. In some cases this figure was lower depending upon the amount of scarred fruit and the variety. The Taylor variety brought about the highest price and the West Indian varieties the lowest price. Fruit could be salvaged for not over 5 to 6 days after the hurricane. Fruit on the ground after that date was too sunburned to salvage. Groves that had not been fertilized for top production and consequently were considerably harder and had less foliage were not damaged as severely as those which had been well fertilized.

Some groves since the hurricane have shown a decided zinc deficiency which has required the use of zinc sprays.

*Persian Limes:* Damage to limes varied

greatly between root-stocks, lemon root-stock, being blown over very easily whereas grapefruit stock held well in the ground. However, I do not recommend the planting of citrus on grapefruit rootstock except on very low land. The greater part of the plantings in Dade County are on lemon root-stock. Cleopatra mandarin root-stock could be classed in between the grapefruit and the lemon root-stock in damage.

Damage to the tops or to the budded part was severe, mainly due to twisting and splitting of the limbs and bark, resulting in considerable infection by *Diplodia*.

In the case of trees that were badly split it was deemed advisable to cut them back to just above the bud. Trees that were not so badly split were pruned back only past the split. In these latter cases, where trees were pruned this way, considerable dead wood is still developing.

Lime trees were put up in much the same

manner as the avocado trees and the fertilizer used was the same. Damage to foliage could be roughly estimated as at least 50%. Trees that were blown over and subsequently propped up are bearing some fruit this year, meaning those limes which were good and were not damaged.

*Mangos*: The damage to Mangos was probably more severe than to any other kind of tropical fruit. Mango trees with limbs having a diameter up to 14 and 16 inches were broken off three to five feet from the ground as well as being blown over, and in some cases, trees were blown out of the ground. Their putting up and care was much the same as for the avocados. It is doubtful if there will be a good crop of fruit on Mangos for three years at least, and perhaps considerably longer. Small mango trees of varieties such as the Brooks and Sandersha were not damaged as severely as the Haden on account of their smaller size.

## THE ALAMOEN—A CITRUS FRUIT OF THE TANGELO TYPE FROM PARAMARIBO

DAVID FAIRCHILD  
*Coconut Grove*

On April 21st, 1914, Mrs. S. T. Rorer, at that time one of the best known authorities on cooking in the United States, sent me three fruits of a new variety of citrus fruit with a letter from her son, James Birch Rorer, who was at this time holding the post of Plant Pathologist in the Department of Agriculture in Trinidad. With the fruits she sent her son's letter in which he said:

"During the past three years I have made several trips to Surinam and have found there a fruit which they call *alamoen*, and which seems to me to be far superior to the grapefruit in flavor. So far as I can learn it is a native of that part of the world; trees are growing everywhere there

and thousands of fruit rotting every year.

Trees come true to seed, I have been told by various planters in Surinam."

The fruits Mr. Rorer sent were large, flattened, rather irregular in shape and with a rather coarse skin which had prominent oil glands like those of the shaddock. They were unlike any shaddocks I had seen. They reminded me of the King orange in their irregularity of shape, but they were much larger and of a light grapefruit color darkened by what appeared to be the rust mite.

Upon opening one of these fruits I discovered that it had inside an unusual structure; a large cavity in the center where ordinarily there is a fibrous core, and with large and very loosely put together "cells" or fruit follicles with thin walls. To my astonishment as I put a spoon into the fruit flesh

to take out a bite to taste, there was none of the usual squirting which generally follows the insertion of a spoon into a grapefruit. It was squirtless, in other words.

In my enthusiasm I took the fruit to my friend Dr. W. A. Taylor, who has tasted more fruits than most of my friends, and was pleased to get his favorable opinion. Dr. W. T. Swingle and Mr. T. Ralph Robinson were neither of them in town at the time.

After having the fruits photographed the seeds were planted and Mr. Rorer's description printed under S.P.I. number 37804, and then there was a long pause. My friends laughed at my claims of a squirtless grapefruit from Paramaribo and wondered at my enthusiasm about Rorer's fruit.

Trees grew from the 117 seeds planted in the Chico, California, Garden and at least two were planted out in the test orchard there. Two of the seedlings were sent to me in 1922 and I planted them on my place at Coconut Grove, which I had recently acquired. The trees at Chico grew well and in time fruited, but the character of the fruit did not come up to expectations. The skin was very thick and there was little juice in the fruit. What there was, however, had an excellent flavor which reminded me strongly of the specimens that had come from Surinam.

I recollect that I was first apprised of its having fruited by seeing my friend Skeels eating one without fully realizing how interested I was in the first fruiting of this alamoen. I took it away from him, together with the others and walked over to see Robinson and ask him about it. As it happened Robinson had just received from the citrus-testing station in Florida a lot of splendid tangelos which he and Swingle were tasting, and the alamoen had to be compared with them. Since my friend Mr. Allison Armour had just arrived on his yacht and had invited Secretary of Agriculture Jardine and the Cuban Minister to lunch on board, and had included both Swingle and me in his invitation, I proposed that Swingle take some of his

tangelos to the luncheon and I would take the alamoen for comparison.

To my delight the guests after a rather desultory taste of the various fruits, decided that the alamoen compared very favorably with any of the tangelos, and in one case a decided preference for it was expressed.

My own trees grew slowly and developed plenty of large spines, but no bloom. My friend Harold Hume took a look at them and scornfully remarked, "Some kind of a shaddock, I suppose." For thirteen years I watched my trees for some sign of blooming, in vain. But in the fall of 1930 to my delight discovered three fruits on one of the trees from late blooms that I had not seen in the spring. They were not as good as those Rorer sent in but much better, I thought, than the fruits from the hot, dry irrigated region of California. Since they were the first fruits, I was encouraged to think that the next crop might be better and I was not disappointed, for in November of 1931, one of the trees bore a half dozen, good sized, characteristic fruits. These were ripe in December when both Swingle and Robinson visited me and it was a great pleasure to take them to the tree and let them taste the alamoen which it had cost so much time and attention to fruit. I think they were both favorably impressed by its characteristic flavor and Swingle expressed the opinion at the time that it was probably a naturally produced tangelo. Robinson compared it with one of those which had been produced by breeding in the experiments of the Office of Plant Breeding Investigations, but Swingle declared the alamoen superior to it.

In January of 1932, Mr. Allison V. Armour invited me to make an expedition to the West Indies and I enquired if we might not get down as far as Surinam so that I could see the alamoen with my own eyes. Since Mr. Rorer had first sent it in we had only received a brief note about it from a Dr. Samuels who reported that it was sometimes called the Guidionapple or Alomoes and that the Dutch name was "Pompalmoes." Since shaddocks are gen-

erally called Pompalmoes by the Dutch in the Orient, the information did not help us any.

Upon our arrival in Paramaribo I searched the market at once to see if there were any alamoens to be found, but it was out of season, and although the dealers all knew about it there were only a few poor specimens to be seen anywhere.

That same afternoon Mr. Armour and I had the pleasure of calling on the Governor of the colony of Surinam, Dr. Rutgers, who for many years was Director of Agriculture in the Dutch East Indies. When he enquired what I was looking for in particular I replied—"for the alamoen." "Oh," said the Governor, "that is my favorite of all the citrus fruits in the colony. I get them whenever I can. I shall give myself the pleasure of presenting you with a box of them tomorrow." Alas, he was not able to find them anywhere. They were out of season.

The day after, when Dr. Stahel took us out on the Saramanca canal, he was able to show me trees of the alamoen and get for me a few fruits, which unfortunately were not representative of what the variety does there, but which had the particular flavor and texture of the fruits which Mr. Rorer had sent me in 1912. I learned that the fruit is never budded but grown from seeds, and that scattered trees only are to be found here and there in the dooryards of the colored people and the planters. It comes true to seed, it seems, and no distinct varieties are recognized in the colony. The centers of these Paramaribo fruits were hollow, and in consequence the fruits were light—lighter than those borne by my trees and much lighter than the fruits that Mr. Rorer sent me years ago. In actual quantity of juice the alamoen cannot compare with a good Florida grapefruit, but I am not claiming that it will ever be a competitor of the grapefruit. I simply say that for my palate, which is perhaps a bit jaded from long and close association with the grapefruit, I like the alamoen very much indeed as a change; and if my trees would only bear respectable crops I

would not eat grapefruits but alamoens, for there is something indescribable in its flavor.

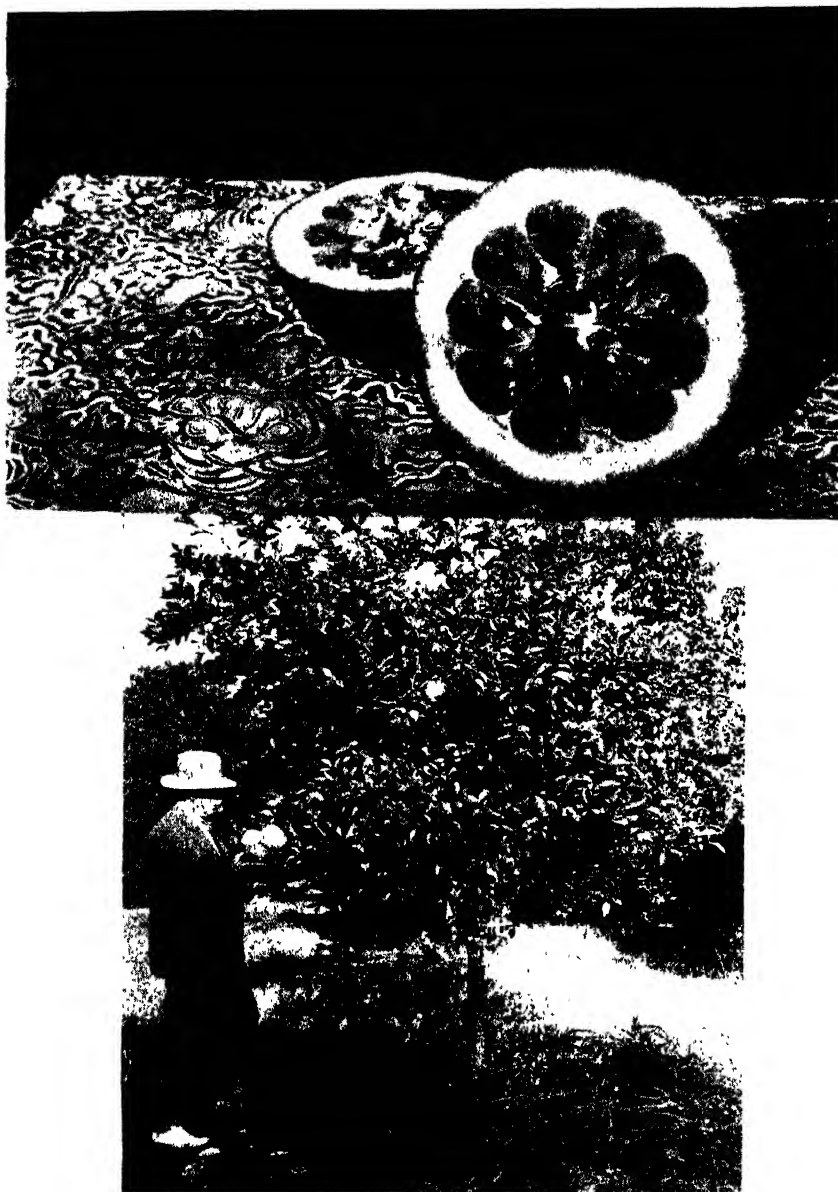
My trees are on their own roots and in Miami limestone rock. What the variety will do when it is budded on a congenial stock and grown in better soil remains to be seen. The further trial of this fruit is a matter for the amateur rather than the commercial grower, for until many things about it are settled it does not appear to be in the commercial class as understood in America.

The above account was written in 1932 and I had intended to publish it, but crush of other things shoved the manuscript aside. Twelve years passed by after that luncheon on the "Utowana" in Washington. Swingle became attached to the University of Miami as botanical expert and I saw much of him. I took him to see my alamoen trees and to taste the fruits, of which I had grown increasingly fond. "Why don't you send a fruit to Webber," said he, "I don't believe he ever saw it." It was late, sometime about April first, and the only fruit left on the tree was scarcely characteristic, but I sent it. The reply was typical of the carefulness with which Webber examined his material and I cannot refrain from quoting from that letter which is now before me.

"Your very interesting letter came yesterday and today the fruit of the alamoen arrived. I have spent the entire forenoon on it. Swingle thought this might be the same as the 'Ugli' fruit grown in Jamaica, but while there are some points of similarity it is quite distinct from that fruit. I only have memory to go by as to flavor, which one cannot record in written characters, but my impression is that the two fruits are much alike in flavor, both being sweet and highly attractive in this character, either I think being superior to the ordinary grapefruit." Webber gives in tabulated form a comparison of the two fruits: their skin thickness, flesh color, seed number and seed character, whether free or fused together and their comparative size.

"The fruits are much alike in shape, exterior color and rugosity, and in large hollow





Dorsett's photographs Dec. 29, 1931.

Fig. 1. Tree of the alamoen on "The Kampong," Coconut Grove, Florida, as it was in December, 1931. An alamoen fruit cut, ready to serve. The fruit follicles are large and loosely packed in their segments, but are thin-walled and full of juice of a characteristic flavor quite unlike that of grapefruit, shaddock or any other citrus fruit. Owing to the thinness of the walls of the follicles and the large natural cavity in the center, it is possible to eat one of these without the juice squirting over one. It is essentially a squirtless fruit. While there is a large amount of juice, the amount does not compare with that contained in a good grapefruit. For its delicious flavor it may come to be grown by amateurs and since it is a good shipper may even find a place on the fancy market.

axis, etc. The Ugli is a little more of 'kid glove' character of peel than the alamoen. The alamoen fruit sent is probably too old to give the full flavor, but it is attractive in flavor. Whether it is sufficiently so as to make it a market fruit, I am very doubtful. I am of the impression that all characters considered, the Ugli is the superior fruit and most likely to make the grade commercially. I have had only four fruits of the Ugli and only one of the alamoen, so my judgement is very untrustworthy."

As I write this long, and to the commercial citrus grower doubtless tiresome account of "just another variety; not commercial," I have cut open a fruit from my tree close by here that went through the hurricane of Sept. 15th and carried its few fruits. It is not ripe but sweet and edible with a large cavity and pulp that is already very juicy and tender. I admit, the looks of the fruit would not sell it to the "average person" if such a thing exists, but strange to say its flavor has become more and more popular on The Kampong and the trees, which stand in small holes dug with a pickaxe, not blasted, in my stony "reef," are curiously

healthy. One of them stands close to three of Swingle's Sampson tangelos which were planted at the same time, 1922, and all of these trees have born fruit since 1930.

"Why run on and on about this 'alamoan fruit?'" I can hear someone in the audience whisper. To such I would reply that it must be because of a habit, an interest in individual plants, not in thousands of acres of them; a habit that dates back to my childhood in the orchard of the Kansas State Agricultural College when Silas Mason, the great horticulturist, was picking dozens of varieties of apple there and knew the characteristics of every one of them; the same personality who later spent months in the Egyptian Sudan describing the date varieties there which even the owners, the fellaheen, had not thought of analyzing.

Mason has gone on and now Webber has gone and before the shades overtake me I feel obligated to leave these rather disconnected notes in your keeping; for with the coming of the frozen fruits and air transport many changes may take place and the alamoen may yet play a role.

# REPORT OF THE AVOCADO VARIETY COMMITTEE

GEO. D. RUEHLE  
*Acting Secretary*  
Homestead

The Avocado Variety Committee has not been very active during the past two years and consequently the acting secretary has very little to report. This is due in part to the fact that the Chairman and the Secretary of the original committee have not been active because of illness, and in part to the occurrence of the devastating hurricane which swept over the Redland district last September. The latter has prevented the obtaining of data on some of the recently registered varieties which would have matured fruit on the trees at the Experiment Station last winter if the hurricane had not occurred.

During the past year only one seedling was registered and a certificate issued to the owner of the original tree.

*Kalusa*. Probably W. I. xGuat. (Flower behavior not recorded). Season July. The Kalusa produces a pyriform fruit of medium size, with a smooth dark green skin, a moderately large seed, and golden yellow flesh of very good quality. It originated on the grove of F. A. Kalusa near Homestead as a seedling

planted about 1930. Its bearing behavior is unknown prior to 1944. In that year it produced 8 bushels and in 1945 about 6 1/2 bushels of fruit, according to the owner. While it has not been observed long enough to ascertain its true value, the Kalusa appears to merit continued trial since it is an early maturing fruit possessing the desirable size, appearance and quality for a commercial avocado.

Two additional owners of seedlings have expressed their intention of registering them, but owing to the fact that no fruit was available for examination by the Committee this year as a result of the hurricane, these will not be registered until later. One of these varieties is being propagated and a good many trees have already been sold and planted. This is the Vanell Late, propagated and sold by the All Good Nursery of North Miami, Florida. This avocado is described by the owner as very late, holding until June, with a fruit medium in size with a small seed and good quality. It may be all that is claimed for it, but it has not been seen by the Committee. The All Good Nursery recently donated three trees to the Experiment Station for a test planting for observation, but it will require a number of years before the merits of this variety can be ascertained.

# REPORT OF THE NECROLOGY COMMITTEE

## IRENE McMAHON O'BYRNE

With the passing of Irene McMahon O'Byrne, the beloved wife of our president Frank M. O'Byrne, The Florida State Horticultural Society has lost a beloved friend. Her life will always be an inspiration to those of us who knew her. Our hearts go out in sympathy to our friend and associate in his loss. Mrs. O'Byrne devoted her life generously to her state and her community. Her devotion to high ideals of service will live on in the Hospital Memorial Home of Lake Wales. Her service to Florida health will be an inspiration to all our members and to her host of friends. She delighted in the tropical beauty of Lake Wales and much of the tropic bloom of her home town is due to her untiring efforts. Friendship has been our gain and her passing is our loss.

Born September 6, 1887

Died April 18, 1946

ed measures are standard practice in many crop producing areas of the State. He described over 30 new species of thrip and built up a department collection of many thousand of insects. There are more than fifty papers in the file on thysanoptera. His name appears as author of several Experiment Station bulletins and numerous papers on pests of citrus and other crops. Professor Watson was a charter member of the Florida Entomological Society and its first President. He was Editor of the Florida Entomologist.

He was a fellow of American Association for Advancement of Science. A fellow of the Entomological Society of America, a member of the American Ecological Society, The Florida State Horticultural Society, Sigma Xi, Phi Kappa Phi and a past president of the Athenæum Club of the University of Florida.

The Society regrets deeply the passing of such loyal and valuable members.

## JOSEPH R. WATSON

Joseph R. Watson died June 6th, 1946 at Gainesville, Florida, where he had lived since 1911. His life was spent in teaching and in field of applied entomology. Previous to coming to the Florida Experiment Station he received his B. S. degree from Baldwin College and his A. M. from Western Reserve. He attended the University of Chicago. Was assistant instructor of biology at Adelbert College. Later he was instructor at Berea College, Kentucky, and Rochester College, Indiana. From 1907 to 1911 he was professor of biology at University of New Mexico.

Mr. Watson had served Florida as head of the Department of Entomology of the Agricultural Experiment Station for 35 years. He initiated the development of biological control using predators and parasites. His recommend-

## HERBERT JOHN WEBBER

With the death of Dr. Herbert John Webber on January 18, 1946, the Florida State Horticultural Society lost one of its most renowned honorary members. At the same time, horticulturists throughout the world lost a beloved and respected leader whose scientific imagination, enthusiasm, and resourcefulness were of inestimable value to the advancement of science in his chosen field of endeavor. The greater part of Dr. Webber's work was in the field of applied science, and the farmers and fruit growers of this country are as much indebted to his long and useful life as is the research profession.

Dr. Webber was born in Lawton, Michigan, on Dec. 27, 1865. His boyhood was spent on his father's farm in Iowa when the pioneer development of that state depended on the

rugged and substantial character of its people in both the mental and physical response which they made to their surroundings. His formal education in Iowa, then in Nebraska, and at Washington University in St. Louis finally was rewarded by his receiving the Ph. D. degree in 1890. Subsequently, the University of Nebraska bestowed the honorary degree of Doctor of Agriculture upon him in 1913, and the University of California paid him the honor of giving him the degree of LL.D. in 1943.

Dr. Webber had a varied and interesting career and held many positions of honor and responsibility in educational and research capacities. He became a resident of Eustis, Florida, in 1892, when in the service of the United States Department of Agriculture. From then until he left the Department in 1907, his enthusiasm for his work in citrus culture and his sincere, friendly regard for the horticulturists of Florida greatly endeared him with many people of the state. This friendship was to endure for the next fifty years and to be revitalized by occasional visits to Florida after his duties had called him far afield.

It is not practical, within the space available, to describe in detail the accomplishments of this long and useful life. Dr. Webber retained the optimistic pioneer spirit, which was so ingrained in his boyhood experiences, to the end of his career. In 1907 he became Professor of Experimental Plant Biology at Cornell University. That endeavor soon resulted in a growing and respected department of Plant Breeding, one of the first such divisions to be established in a state agricultural college. He soon was surrounded by graduate students and research workers, whose appreciation for Dr. Webber's kindly, enthusiastic, and stimulating leadership has become one of their most cherished memories. His reputation went far, and in 1913 he was called to California to organize the Graduate School of Subtropical Horticulture and Citrus Experi-

ment Station. Again his pioneer spirit and vision enabled him to build this new institution on broad and sound fundamental policies which have endured and unfolded with notable success during the past thirty years.

He was an ardent believer in the goodness and helpfulness of his fellow men, and, as a part of his early endeavor to help the fruit growers of California, he was active in organizing for the first time the annual institutes which serve several different crops, including citrus, avocados, and dates. These two last mentioned crops were barely started in a commercial way, but Dr. Webber's enthusiasm carried along the early meetings, and his optimistic faith in their future was the inspiration of many pioneer planters of dates and avocados. His high regard for the value of the Florida State Horticultural Society to that state, and a similar society to the apple growers of western New York, gave him faith in the promotion of similar activities in California.

Dr. Webber's writings were a notable portion of the scientific articles on agriculture and horticulture during a period of fifty years. Perhaps his crowning achievement was the contribution of several chapters and his editorial guidance in the publication of volume I (History, Botany, and Breeding) of *The Citrus Industry*. He was busily engaged in his editing of volume 2 of this work when death overtook him after an illness of only a few days. He had completed the writing of two chapters, one on nursery methods and the other on rootstocks, for this volume, and had edited most of the chapters contributed by others.

His host of friends have had their lives enriched by their association with this lovable and inspiring personality.

Leon D. Batchelor  
Riverside, California  
January 18, 1947

# ANNUAL REPORTS

## REPORT OF SECRETARY

May 2, 1946.

All money previously handled by the secre-

tary has been transferred to the account of the treasurer, and hereafter will be handled by that office.

## TREASURER'S ACCOUNT

### STATEMENT OF FINANCIAL CONDITION FOR PERIOD

ENDING APRIL 25TH, 1946

#### ASSETS:

##### Exchange National Bank:

Cash on hand — savings account .....	130.18	
Cash on hand — checking account .....	\$ 1,974.24	

		\$ 2,104.42
Endowment Capital .....		6,718.50
		<hr/>
Total Assets .....		\$ 8,822.92

#### LIABILITIES & CAPITAL:

##### Memberships:

Life .....	576.00	
Patron .....	500.00	1,076.00

Contributions .....		14.00
Earned Interest, Endowment .....		.72
Interest Received on Savings .....		2.86
Capital Account .....		7,729.34

Total Liabilities & Capital .....		\$ 8,822.92
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### STATEMENT OF RECEIPTS & DISBURSEMENTS FOR PERIOD

MAY 16, 1945 TO APRIL 25, 1946, INCLUSIVE

#### RECEIPTS:

Cash on hand May 15, 1945 (checking acc't.) .....		\$ 2,197.72
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##### Memberships:

Annual .....	628.55	
Sustaining .....	1,120.00	1,748.55

Proceedings Sales .....		56.00
Ralph P. Thompson, Asst. Secy. ....		180.00

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\$ 4,132.27

## DISBURSEMENTS:

Stationery & Supplies .....	58.30
Telephone & Telegraph .....	123.62
Miscellaneous Expense .....	197.61
Convention Expense .....	268.50
Proceedings Expense .....	400.00
U. S. Savings Bond .....	1,110.00

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 2,158.03

CASH ON HAND—April 25, 1946 (checking acc't)

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 \$ 1,974.24

## PROFIT &amp; LOSS STATEMENT FOR PERIOD

MAY 16, 1945 TO APRIL 25, 1946, INCLUSIVE

## INCOME:

## Memberships:

Annual .....	628.55	
Sustaining .....	1,120.00	1,748.55

Proceedings Sales .....	56.00
Ralph P. Thompson, Asst. Secy. ....	130.00

---

 Total Income ..... \$ 1,934.55

## EXPENSES:

Stationery & Supplies .....	58.30
Telephone & Telegraph .....	123.62
Miscellaneous Expense .....	197.61
Convention Expense .....	268.50
Proceedings Expense .....	400.00

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 Total Expense ..... \$ 1,048.03

Net profit for the Period .....

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 \$ 886.52

## REPORT OF AUDITING COMMITTEE

We, the members of the Auditing Committee, beg to report that we have examined the books, vouchers, holdings and reports of the Treasurer of the Society, for the period May 16, 1945 to April 25, 1946, inclusive, and find them to be correct.

A. M. Tilden, Acting Chairman  
H. B. Snively  
W. L. Tait

## REPORT OF EXECUTIVE COMMITTEE

Four meetings of the Executive Committee were held during the past year.

On December 4, at a meeting held in Winter Haven, Dr. Ralph L. Miller was elected to fill the office of Secretary.

It was agreed to send a complete set of the Proceedings to the University of the Philippines in Manila to replace that destroyed by the Japanese.

On January 18, a meeting was held in Winter Haven. It was agreed that all moneys be handled by the office of the Treasurer. Assistant Secretary Ralph Thompson was authorized to insure all copies of the Proceedings at \$1 each. Life memberships were set at \$50 each.

On March 20, a meeting was held in Miami, Florida in order to make arrangements for the coming Convention, April 30 to May 2. The following members of the local committees were present:

Miller T. Mercer	Joe Powers
David Hughes	Norman Cox
Jack Faircloth	Frank Stirling
C. A. Bass	Floyd Ray
Mrs. Cora Link	George Ruehle
Miss Margaret J. Mustard	

It was agreed to have no speaking at the banquet, to accept an invitation to Fairchild Gardens, to have name tabs for visiting members, and to arrange for a trip to Cuba for those wanting to go after the Convention.

On April 30, at the beginning of the Convention, an executive meeting was called at

which Mrs. S. L. Frisbie was present, in order to discuss the 1945 Proceedings. In order to facilitate publication hereafter, it was agreed to have a publication committee, the chairman of which to be the Secretary and composed of the Assistant Secretaries and Vice Presidents. This group to work out details of sending out proper proof and determining editorial policies.

On May 2, before the entire Convention, it was agreed to change the meeting time from spring to fall, to raise the annual dues from \$2 to \$3 and to have the next Annual Meeting in October, 1947 at a place chosen by the Executive Committee.

## REPORT OF NOMINATING COMMITTEE

Your Nominating Committee recommends the following to serve as officers of the Florida State Horticultural Society during the coming year:

President, Frank M. O'Byrne.

Vice Presidents, 1. Frank Stirling, 2. Earl W. Hart, 3. W. F. Ward, 4. Geo. D. Ruehle—Krome Memorial Institute, 5. Dr. David Fairchild—Honorary Krome Memorial Institute, Lyle Dickman—Vegetable Section.

Secretary, Ralph L. Miller.

Assistant Secretaries, Ralph Thompson, H. S. Wolfe, F. S. Jamison.

Treasurer, Frank L. Holland.

Sergeant at Arms, J. F. Alexander.

Executive Committee, R. S. Edsal, C. D. Kime, Lem P. Woods, Floyd Wray, Dale Talbert, L. R. McLain, chairman.

There being no nominations from the floor, the above officers were unanimously elected.

## REPORT OF THE RESOLUTIONS COMMITTEE

WHEREAS: The Florida State Horticultural Society adopted a resolution at its 58th Annual Meeting calling on its officers to at-



tempt to organize the Citrus Industry representatives in the States of California, Texas and Florida to finance and direct an investigation into the cause and means of spread of the "Tristeza disease" of citrus trees on Sour Orange Stock, and

WHEREAS: Texas and Florida remain the only states committed to this investigation under the direction and at the expense of their respective states, now therefore be it

RESOLVED: That the Florida State Horticultural Society in session at Miami, Florida, this second day of May, renews its demand for an early investigation of this serious disease and calls upon the Governor and his cabinet and all departments of the State government charged with the protection of our horticulture to cooperate to see that this investigation is financed and instituted at the earliest possible date and that it be continued to a successful conclusion, and be it further

RESOLVED: That the United States Department of Agriculture be invited to cooperate in this investigation.

#### RESOLUTIONS ADOPTED BY THE FLORIDA STATE HORTICULTURAL SOCIETY AT MIAMI, MAY 2, 1946

Whereas, the prosperity of the state and nation's horticultural and agricultural interests is dependent in large measure upon prevention of entry of additional plant pests capable of increasing the annual loss now caused by introduced pests and estimated to be \$1,500,000,000 annually, and

Whereas, Florida, by reason of its geographical location is exposed more than most states to the introduction of insects and diseases from tropical countries; its climate is such as to permit the ready establishment and spread of such pests as may be introduced; and its transportation facilities, particularly air traffic, are so highly developed as to magnify very greatly the possibilities of introduction of alien plant pests; therefore be it

Resolved, that the members of the Florida

State Horticultural Society, individually and collectively, communicate with their representatives in Congress and request that they use their influence and direct their efforts to the end that:

1. Senate Bill 1990, providing for amendment to the National Plant Quarantine Act of 1912, so as to provide the Secretary of the USDA with authority to regulate more effectively the entry of foreign plants, be enacted into law;

2. The appropriation for the Department's foreign plant quarantine enforcement in the sum of \$1,552,000 now before Congress be increased by \$200,000, to enable the Department to expand the defense against entry of foreign plant pests through employment of additional personnel to make surveys in foreign countries, so as to obtain first hand information as to pest conditions present therein, and to develop suitable means for the treatment of imported commodities;

3. The Department be provided with funds necessary to complete the eradication of citrus canker from the several states in which this destructive disease has been reported during the past several years. And be it further,

Resolved, that the Secretary of the Society be, and hereby is, instructed to send copies of this resolution to all members of the Florida Congressional delegation, to the Honorable Clinton Anderson, Secretary of Agriculture, and to Dr. P. N. Annand, Chief, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

#### FINAL RESOLUTIONS

The members attending the 59th Annual Meeting of the Florida State Horticultural Society in Miami, April 30, and May 1 and 2, wish to express their thanks to the following:

1. To Miller T. Mercer and David Hughes, and their families and friends who so ably directed the activities of the local committees

in making efficient arrangements for the meeting.

2. To the city of Miami, and particularly Joe Powers and Norman Cox for their efforts in management of the Convention.

3. To the Columbus and McAllister Hotels, who through their many courtesies helped make the meeting a success.

4. To the local and state papers and radio stations for assistance in publication of the meetings.

5. To the many speakers who have accepted invitations to take places on our program.

6. To the University of Miami, and particularly Margaret J. Mustard for their assistance and courtesies.

7. To Dr. David Fairchild for his courtesy in arranging a trip and a tea at Fairchild Gardens.

Respectfully submitted,  
RESOLUTIONS COMMITTEE

## DECEASED MEMBERS

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THOMAS BARBOUR

FOREST P. LINDLEY

IRENE McMAHON O'BYRNE

ALEXANDER RAY

JOSEPH R. WATSON

HERBERT JOHN WEBBER





**PROCEEDINGS**  
OF THE  
**SIXTIETH ANNUAL**  
**MEETING**  
OF THE  
***Florida State Horticultural***  
***Society***  
*And Its Affiliates*

HELD AT  
ST. PETERSBURG, FLORIDA  
OCTOBER 28, 29 and 30

**1947**



Published by The Society

Office of Publication  
ROBINSONS CHIEF PRESS  
APOPKA, FLORIDA



# Florida State Horticultural Society

## Officers Elect for 1948

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### PRESIDENT

W. F. WARD  
Avon Park

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EARL W. HART  
Avon Park

FRANK STIRLING  
Ft. Lauderdale

LYLE C. DICKMAN  
Ruskin

DR. DAVID FAIRCHILD  
Honorary  
*Krome Memorial Institute*  
Coconut Grove

DR. G. D. RUEHLE  
*Krome Memorial Institute*  
Homestead

W. H. SCHNECK  
*Vegetable Section*  
Plant City

R. J. WILMOT  
*Ornamental Section*  
Gainesville

---

### SECRETARY

DR. RALPH L. MILLER, Plymouth

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### ASSISTANT SECRETARIES

RALPH H. THOMPSON, Winter Haven

J. FRANCES COOPER, Gainesville

DR. F. S. JAMISON, Gainesville

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### TREASURER

LEO H. WILSON, Bradenton

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### EXECUTIVE COMMITTEE

DR. J. R. BECKENBACH, Bradenton  
*Chairman*

LEM P. WOODS, JR., Tampa

FRANK L. HOLLAND, Winter Haven

R. S. EDSALL, Wabasso

DALE TALBERT, Vero Beach





# CONSTITUTION

Article 1 This organization shall be known as the Florida State Horticultural Society, and its object shall be the advancement of Horticulture.

Article 2 Any person or firm may become an annual member of the Society by subscribing to the Constitution and paying three dollars. Any person or firm may become a perennial member of the Society by subscribing to the Constitution and paying the annual dues for five or more years in advance. Any person or firm may become an annual sustaining member of the Society by subscribing to the Constitution and paying ten dollars. Any person may become a life member of the Society by subscribing to the Constitution and paying fifty dollars. Any person or firm may become a patron of the Society by subscribing to the Constitution and paying one hundred dollars.

Article 3 Its officers shall consist of a President, three Vice Presidents, Secretary, Assistant Secretaries, Treasurer and Executive Committee of five, who shall be elected by ballot at each annual meeting. These officers shall take their positions immediately following their election. The duties of the Assistant Secretaries shall be outlined and supervised by the Executive Committee.

Article 4 The regular annual meeting of this Society shall be held on the second Tuesday in April, except when ordered by the Executive Committee.

Article 5 The duties of the President, Vice Presidents, Secretary and Treasurer shall be such as usually devolve on these officers. The President, Secretary and Treasurer shall be ex officio members of the Executive Committee.

Article 6 The Executive Committee shall have authority to act for the Society between annual meetings.

Article 7 The Constitution may be amended by a vote of two-thirds of the members present.

Article 8 A section of the annual program of the Society shall be devoted to the discussion of sub-tropical fruits, exclusive of the commonly grown varieties of citrus fruits. This section shall be known as the KROME MEMORIAL INSTITUTE. It shall be presided over by a fourth vice president who shall be elected by ballot at each annual meeting of the members in attendance at the Institute. The fourth vice president shall be an ex-officio member of the Executive Committee.

Article 9 The Executive Committee may, at its discretion and on the basis of merit, nominate not to exceed five persons in any one year, for Honorary Membership in the Society. Honorary members shall enjoy all privileges of the Society.

Article 10 A section of the annual program of the Society shall be devoted to the discussion of vegetables and other truck crops. This section shall be known as the VEGETABLE SECTION OF THE FLORIDA STATE HORTICULTURAL SOCIETY. It shall be presided over by a Vice President, who shall be elected at each annual meeting of the Society by the members in attendance at the Session. The Vice President shall be an ex-officio member of the Executive Committee.

## BY - LAWS

1. The Society year shall be coextensive with the calendar year, and the annual dues of members shall be three dollars.

2. All bills authorized by the Society or its Executive Committee, for its legitimate expenses, shall be paid by the Secretary's draft on the Treasurer, O. K'd by the President.

3. The meetings of the Society shall be devoted only to Horticultural topics, from scientific and practical standpoints, and the presiding officer shall rule out of order all motions, resolutions and discussions tending to commit the Society to partisan politics or mercantile ventures.

4. All patron and life membership dues and all donations, unless otherwise specified by donor, shall be invested by the Treasurer in United States Government bonds. The earnings from these bonds shall be left as accrued values or reinvested in United States Government bonds of a guaranteed periodical value unless it is ordered by the Executive Committee or the Society that such earnings can be made available for operating expense. Receipts from perennial membership dues shall be placed on deposit at interest by the Treasurer. Only three dollars (\$3.00) from each perennial membership fee shall be available during any calendar year for payment of operating expenses of the Society.

# LIST OF MEMBERS

## 1947

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### HONORARY MEMBERS

Chase, J. C., Winter Park	Holland, Spessard L., Bartow
Fairchild, Dr. David, Coconut Grove	Hume, Dr. H. Harold, Gainesville
Floyd, W. L., Gainesville	Lapsey, L. W., Blanton
Haden, Mrs. Florence P., Coconut Grove	Mayo, Nathan, Tallahassee
Hastings, H. C., Atlanta, Ga.	Robinson, T. Ralph, Terra Ceia
Henricksen, H. C., Eustis	Swingle, Dr. W. T., Washington, D. C.

### PATRON MEMBERS

American Agricultural Chemical Co., Pierce	Gulf Fertilizer Co., Tampa
American Fruit Growers, Inc., Maitland	Hastings, H. G. Co., Atlanta, Ga.
Angelbilt Hotel, Orlando	Hillsboro Hotel, Tampa
Armour Fertilizer Works, Jacksonville	Klemm, A. M. & Son, Winter Haven
Buckeye Nurseries	Lake Garfield Nurseries, Bartow
Chase & Co., Sanford	Manatee Fruit Co., Palmetto
Coral Reel Nurseries Co., Homestead	Mills The Florist, Jacksonville
Deerfield Groves, Wabasso	Nocatee Fruit Co., Nocatee
Deering, Chas.	Oklawaha Nurseries Co., Inc., Lake Jim
Exchange Supply Co., Tampa	Peninsula Chemical Co., Orlando
Exotic Gardens, Miami	Schnarr, J. & Co., Orlando
Florida Citrus Exchange, Tampa	Southern Crate Manufacturing Assn.
Florida East Coast Hotel Co., St. Augustine	Stead, Lindsay, P. O. Box 809, Ft. Pierce
Florida Grower Publishing Co., Tampa	Thomas Advertising Service
The Fruitlands Co., Lake Alfred	U. S. Phosphoric Products, Tennessee Corporation, 61 N. Broadway New York, N. Y.
Gardner, F. C., Lake Alfred	Van Fleet Co., Winter Haven
Glen St. Mary Nurseries Co., Glen St. Mary	Wilson & Toomer Fertilizer Co., Jacksonville

All addresses are in Florida unless otherwise shown.

## LIFE MEMBERS

- Agricultural Exp. Station, Puerto Rico  
 Albertson Public Library, Orlando  
 Allenbrand, Alfred, Box 288, Frostproof  
 Alderman, A. D., Bartow  
 Andrews, C. W., John Crerar Library,  
 Chicago, Ill.  
 Barber, C. F., Macclenny  
 Bartlum, W. Leonard, Fla. Agr. Supply Co.,  
 Orlando  
 Berger, Mrs. E. W., Gainesville  
 Bouis, Clarence G., Box 6, Ft. Meade  
 Bringham, M. S., Micco  
 Britt, John F., Ft. Pierce  
 Brown, A. C., Gainesville  
 Bullard, Henry F., c/o Bullard & Sprott,  
 Lake Wales  
 Carnegie, Mrs. T. M., Fernandina  
 Champlain, A. E., RFD No. 1, Palmetto  
 Chase, Josua C., Winter Park  
 Chidester, D. D., 446 Painter Ave.,  
 Whittier, Calif.  
 Christiancy, Cornelius, Port Orange  
 Clement, Waldo P., Georgiana  
 Conner, Wayne E., New Smyrna  
 Cook, R. F., Leesburg  
 County Agr. Agent Orange Co., Orlando  
 Crutchfield & Woolfolk, Pa. Produce Bldg.,  
 Pittsburgh, Pa.  
 Dunedin Public Library, Dunedin  
 Ellsworth, Wilma J. (Miss), Rt. No. 1,  
 Dade City  
 Fairchild, Dr. David, Coconut Grove  
 Fugazzi, John, c/o Fugazzi Bros.,  
 Clearwater  
 Gifford, Dr. John, Coconut Grove  
 Guest, Mrs. Amy, N. Ocean Blvd.,  
 Palm Beach  
 Haden, Mrs. Florence P., Coconut Grove  
 Hakes, L. A., Box 771, Orlando  
 Hastings, H. G., 16 West Mitchell St.,  
 Atlanta, Ga.  
 Henricksen, H. C., Box 1045, Eustis  
 Hernandez, Pedro, 108 Cienfuegos,  
 San Fernando, Cuba  
 Hollingsworth, G. S., Arcadia  
 Hume, H. Harold, Gainesville  
 Iowa State College Library, Ames, Iowa  
 Jacocks, A. J., Winter Haven  
 Lassen, H. C., Garden Spring Terrace,  
 Saratoga, Calif.  
 Lauman, G. N., Ithaca, N. Y.  
 Leonard, George V., Hastings  
 Manatee Fruit Co., 1st Natl. Bk Bldg.,  
 Tampa  
 Martin, A. Wm., Box 36, Sebastian  
 Mathews, E. L., Plymouth  
 McCarty, B. K., Eldred  
 McCarty, Mrs. C. T., Eldred  
 Merritt, Dr. J. C., 297 Sherman St.,  
 St. Paul, Minn.  
 Michael, A. B., Wabasso  
 Montgomery, Robert H. (Colonel)  
 Coconut Grove  
 Montgomery, Mrs. Robert H.,  
 Coconut Grove  
 Mountain Lake Corporation, Lake Wales  
 O'Byrne, Frank M., Lake Wales  
 Ohmer, C. J., West Palm Beach  
 Olivebaum, J. E., Clermont  
 Pedersen, W. L., Winter Haven  
 Pennock, Henry, Sr., Jupiter  
 Phillips, Dr. P. & Sons, Orlando  
 Phipps, John S., N. Ocean Blvd.,  
 Palm Beach  
 Phipps, H. C., N. Ocean Blvd.,  
 Palm Beach  
 Phipps, Howard, Delray Beach  
 Pike, W. N., Blanton  
 Plymouth Citrus Growers Assn, Plymouth  
 Prosser, Lew, Plant City  
 Raulerson, J. Ed., Arcadia  
 Reasoner, N. A., Bradenton  
 Reid, W. C., Largo  
 Rhode, H., Sebring

Ricketson, Mrs. M. C., "Grayfield,"  
Fernandina

Sample, J. W., Haines City

Sandlin, A. R., Leesburg

Schuman, Albert, Sebastian

Sellards, Dr. E. H., State Geologist,  
Austin, Texas

Sloan, G. D., Box 1021, Tampa

Stanton, F. W., Dock & Walnut Sts.,  
Philadelphia, Pa.

Stead, Lindsay, Box 809, Ft. Pierce

Stevens, Edmund, Verge Alta, Puerto Rico

Stuart, L. E., Montemorelos, Mexico

Taber, Mrs. George L., Glen St. Marys

Taylor, J. S., Largo

Thomas, Jefferson, Gainesville

Todd, E. G., Avon Park

Towns, Thomas R., Holguin, Cuba

Trelease, Wm., University of Illinois,  
Urbana, Ill.

Trueman, Roy B., Trueman Fert. Co.,  
Jacksonville

Von Borowsky, Miss Lisa, Brooksville

Wilson & Toomer Fertilizer Co., Box 4459,  
Jacksonville

Wirt, E. L., Box 144, Babson Park

Woods, L. R., Tampa

Yothers, W. W., 457 Boone Street, Orlando

Fawcett, Chas. F., Box 186, Orlando  
Florence Citrus Grs. Ass'n, Florence Villa  
Fla. Agr. Research Inst., Box 392,

Winter Haven

Floridagold Citrus Corp., Lake Alfred

Gardner, F. C., Lake Alfred

Giddings, W. W., Polk Packing Co.,  
Winter Haven

Grant, A. J., 259 Scotland St., Dunedin

Growers Fert. Coop., Lake Alfred

Gulf Fert. Co., Box 2721, Tampa

Haines City Heights, Haines City

Hartt, S. Y. & Son, Box 308, Avon Park

Hawkins, H. E. C., St. Augustine

Hicks, W. B., c/o Wilson & Toomer Fert.  
Co., Jacksonville

Hodnett, J. Victor, Winter Haven

Hunt, D. A., c/o Hunt Bros. Inc.,  
Lake Wales

Jones, R. S., Wilson & Toomer Fert. Co.,  
Jacksonville

Klemm, A. M. & Son, Winter Haven

Kramer, L. H., Lake Wales

Lyons Fertilizer Co., Box 310, Tampa

McDonald Corp. Wm. P., Auburndale

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Naco Fert. Co., Box 1114, Jacksonville

Nicholson, Donald F., Orlando

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Palm Harbor Citrus Growers Association,  
Palm Harbor

Pasco Growers Cooperative, Dade City

Peninsular Fert. Works, Box, 1273, Tampa

Pinkerton, J. B., City Point

Raoul, Loring, The Raoul Co., Sarasota

Rickborn, J. H., Box 1401, Lakeland

Roess, M. J., Box 388, Jacksonville

Rogers, Walter M., Sunrise Theatre Bldg.,  
Ft. Pierce

#### SUSTAINING MEMBERS

Adams Groves, Lake Alfred

Alexander, J. F., Bartow

Adams Packing Assn, Auburndale

Brown, Mrs. Vet L., Bartow

Bryan, R. L., Bartow

Chase, Randall, Sanford

Clark, John D., c/o Waverly Grs. Coop.,  
Waverly

Dixie Lime Products Co., Ocala

Dolomite Products, Inc., Ocala

Faircloth, Jack, S. Dixie, West Palm Beach

Farm & Home Machinery Co., Inc.,  
Orlando

Ryburn, Alexander, Box 977, Vero Beach  
 Skinner, Francis L., 379 Monroe St.,  
 Dunedin  
 Slough Grove Co., Inc., Dade City  
 Smith, Francis Prescott, Box 442, Winter  
 Haven  
 Snively Grove, Winter Haven  
 Snively, Thomas V., Winter Haven  
 Swann, Thomas B., Box 232,  
 Winter Haven

U. S. Phosphoric Products, Division  
 Tennessee Corp., Box 3269, Tampa

Virginia-Carolina Chemical Corp.,  
 Box 2311, Orlando

Wakelin, G. N., Tavares  
 Walker, Ralph N., Auburndale  
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 Waring, W. L. Jr., Box 310, Tampa  
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 Wolfe, J. C., Box 310, Tampa  
 Woods, Fred J., Box 2721, Tampa  
 Woods, Lem P., Box 2721, Tampa  
 Wray, Floyd L., Hollywood

#### ANNUAL MEMBERS

##### 1947 FLORIDA

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 Ft. Lauderdale  
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 American Agr. Chemical Co.,  
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 Boltin, H. H., Pasco Packing Co.,  
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 Burg, Roy N., Loxahatchee  
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 Burpee Co., W. Atlee, Sanford  
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 Butts, Don A., Fla. Citrus Com., Lakeland  
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- California Spray Chem. Corp., Box 1231,  
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 Charles, Wilbur G., Box 323, Winter Haven  
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 Chase, Randall H., Sanford  
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 China Tung Oil, Inc., Gainesville  
 Chryst, T. L., Bradenton  
 City of Lakeland, Lakeland  
 Clearwater Growers Ass'n., Clearwater  
 Coe, Dana G., Providence Rd., Lakeland  
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 Colee, Harold, Hildebrandt Bldg.,  
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 Homestead  
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 Gainesville  
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 DeVaney, A. M., Weirsdale  
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 Dickman, Dr. M. T., U. of Miami, Miami  
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 Dye, Alfred M., Everglades Fert. Co.,  
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 Eide, Andrew, c/o J. G. Sample, Naples  
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 Fairchild, Dr. David, 4013 Douglas Rd.,  
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 Lake Alfred  
 Florida Farm Bureau, c/o John Ford,  
 Orlando  
 Fla. Citrus Prod. Credit Ass'n.,  
 c/o Harold L. Wilson, Jr., Bartow  
 Fla. Citrus Prod. Credit Ass'n.,  
 c/o Al Whitmore, Orlando  
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 Jones, W. J., c/o DiGiorgio Fruit Corp.,  
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 Kanawha Groves Co., Ft. Pierce  
 Kaspar, P. E., Sherwin Williams Co.,  
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 Kazaros, Robert S., 1610 Delaney St.,  
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 Keenan Laboratories, Frostproof  
 Keene, R. D. Inc., Winter Garden  
 Kelsheimer, E. C., Veg. Crop Lab.,  
 Bradenton  
 Kendall, Harold E., Box 186, Goulds  
 Kensett, J. G., 2612 Jetton Ave., Tampa  
 Kent, L. D., 3860 Poinciana Ave., Miami 33

- Kent, Miss Olga, 3850 Pomciana Ave.,  
Miami 33
- Kew, Theodore J., 1721 Westchester Ave.,  
Winter Park
- Kilgore Seed Co., Plant City
- Kime, Chas. D. Jr., Rt. 1, Box 130,  
Winter Haven
- Kinard, R. R., Box 607, Homestead
- King, Batty, Bonita Springs
- King, John R., State Plant Board,  
Gainesville
- Kingham, Fern, Box 53, Davenport
- Kinsey Groves, (Mrs. Juliet Fox),  
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- Krome, Wm. H., Box 596, Homestead
- Krome, Mrs. Wm. H., Box 596, Homestead
- Lamont, Henry, Rt. 2, Ft. Pierce
- Langley, J. A., Haines City
- Lawless, W. W., Lake Alfred
- Lec, C. S., Oviedo
- Leonard, Geo. A., Hastings
- Lewis, H. F., Terra Ceia
- Lipscomb, S. F., Bartow
- Lipsey, L. W., Blanton
- Little, C. S., (Lyons Fert. Co.), Odessa
- Livingston, Bert, Florida Grower, Tampa
- Logan, John Henry, Box 540, Clearwater
- Long, J. S., City Hall, Tampa
- Loudon, Hugh R., Box 75, Babson Park
- Lowles, Amos W., Box 246, Port Orange
- Lucas, Glenn, Box 564, Leesburg
- Luckhardt, Robert L., A. A. F. Regional  
Hosp., Coral Gables
- MacCarthy, H. P., 5911 Cherokee Ave.,  
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- McClanahan, H. S., John F. Seagle Bldg.,  
Gainesville
- McClure, John F., Palmetto
- McCormack, Jack, Radio Sta. WGBS,  
Miami
- MacDowell, Dr. L. G., Fla. Citrus Comm.,  
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- McKinnon, W. M., 901 Magnolia Ave.,  
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- McLane, W. F., (Lyons Fert. Co.)  
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- McNutt, M. H., c/o McNutt-Heasley,  
Orlando
- McPeck, John K., 328 S. Lakeview Dr.,  
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- McSweeney, W. M., Box 2721, Tampa
- Magie, R. O., Bradenton
- Manatee Fruit Co., G. C. Valentine, Mgr.,  
Palmetto
- Martin Seed Co., 202 East Bay St.,  
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- Masek, John, Apopka
- Mathias, A. C., Box 773, Haines City
- Maughn, A. A., 1852 Washington Ave.,  
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- Mayfield, Harry, 608 Easton, Orlando
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- Menninger Nursery, Stuart
- Mershon, Claud, 3433 Pine Tree Rd.,  
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- Mercer, Miller T., Box 181, Coral Gables
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- Michael, Joe E., Palmetto
- Michael, Joe W., Wabasso
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- Moore, Clarence H. & Eva M., Box 31,  
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- Moore, Edwin L., USDA Citrus Lab.,  
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- Moore, W. D., 501 S. Andrews Ave.,  
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- Morrow, Wm. B., Ft. Myers
- Morton, Julia F., Rt. 1, Box 154, Homestead
- Morris, R. E., Tavares
- Mowry, Harold, Exp. Sta., Gainesville
- Mustard, Margaret J., U. of Miami,  
Coral Gables
- Muiton, O. C., Naco Fert. Co., Ft. Pierce
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- Noble, Dr. C. V., Fla Exp. Sta.,  
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- O'Byrne, Mrs. Frank M., 15 Lakeshore  
Blvd., Lake Wales
- O'Kelley, E. B., A. C. L. Ry. Co.,  
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- Oxer, V. T., Sebring
- Ochse, Dr. T. T., U. of Miami, Miami
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- Padgett, R. L., Box 310, Tampa
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- Palmer, J. M., Lutz
- Palm Harbor Citrus Grs. Ass'n,  
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- Parker, Coleman H., Winter Haven
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- Peebles, T. A., Box 877, Vero Beach
- Pierce, Wm. R., Box 125, Winter Haven
- Pinkerton, D. W., City Point
- Platts, Norman G., Ft. Pierce
- Pollard, W. R., Box 587, Bradenton
- Pollard, H. S., c/o McDonald Corp.,  
Auburndale
- Pollard, Rox, Box 500, Auburndale
- Pomona Citrus Packers (A. J. Rinck)  
Crescent City
- Prall, Phil W., 163 Ave. A., S. W.,  
Winter Haven
- Preston, Hoyden, Manatee Fruit Co., Tampa
- Price, R. C., Box 2721, Tampa
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- Pringle, H. L., Leesburg
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- Rich, Frank H., 115 8th St. SE.,  
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- Roberts, A. S., Wilson & Toomer Fert. Co.,  
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- Ross, S. W., Lake Wales
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- Roy, Wallace R., Box 3028, Vacuum Foods,  
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- Shore, R. O., c/o Brooks Inc., Homestead
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- Smith, C. B., Box 821, Orlando

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 Stevens, Harold E., Amherst Apts., Orlando  
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 Stout, G. J., U. of F., Gainesville  
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 Suit, Dr. R. F., Citrus Exp. Sta.,  
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 Corp., Orlando  
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 Thompson, W. L., Lake Alfred  
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 Todd, E. G., Avon Park  
 Tomasello, Rudolph P., Palm Beach  
 Truemen Fertilizer Co., 1015 Lynch Bldg.,  
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 Walker, Ralph N., Rt. No. 1, Box 165,  
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 Whitesell, S. A., Largo  
 Whitson, Edmund S., Clearwater  
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 Williams, Miss Myra G., Rockledge  
 Williams, Ralph E., American Fruit Grs.,  
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#### ADDITIONAL ANNUAL MEMBERS (Late Returns)

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Patrick, Dr. Roger, Box 403, Winter Haven

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Acme Agency, Casilla Especial 16, Buenos  
Aires, Argentina  
American Cyanamid Co., 30 Rockefeller  
Plaza, N. Y. City, N. Y.  
American Potash Institute, Inc., 710 Mort-  
gage Guarantee Bldg., Atlanta, Ga.

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Benitez, Lic. Jose, Adificio La Nacional  
Monterey N. L. Mexico  
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Detroit, Mich.  
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Carmon, Dr. Y., Box 47, Tel Aviv, Palestine  
Chipman Chemical Co., Bound Brook,  
New Jersey  
Coit, J. Eliot, Box 698, Fallbrook, California  
College of Agric. & Mech. Arts, Mayaguez,  
Puerto Rico  
Cooper, Wm. C., Box 241, Weslaco, Texas  
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Copper Co., Calumet, Mich.  
Curry, Kenneth, 1600 Melrose Place,  
Knoxville, Tenn.  
Dierberger Agro-Comercial LTDA,  
Sao Paulo, Brazil  
Friend, W. H., Valley Exp. St.,  
Weslaco, Texas  
Hamilton, Jos., Rt. No. 1, Box 449,  
Yuma, Ariz.  
Hastings, H. G., Atlanta, Ga.  
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Chem. Corp., Winchester, Va.  
Henry, Arthur M., 1177 Zimmer Dr. N. E.,  
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Husmann, Dr. Merman, Box 725,  
Clemson, S. C.  
Marzo, Agnes, Rt. No. 3, Box 296-A,  
Anaheim, Cali.  
Maulhardt, Richard, Rt. No. 1, Box 294-D,  
Camarillo, Cali.  
Mispley, R. G., Crown Zellerbach Corp.,  
Camas, Washington  
Q. Dr.—02553, Officer In Charge, Nelspruit  
Subtropical Hort. Res. Sta., Nelspruit,  
South Africa

- Morales, F. G., Reina 113, Havana, Cuba
- National Fert. Ass'n, 616 Investment Bldg.,  
Washington, D. C.
- Niagara Sprayer & Chem. Division  
Middleport, N. Y.
- Nikitin, A. A., College Park, Ga.
- Pacific Coast Borax Co., 51 Madison Ave.,  
New York, N. Y.
- Pearson, Wm. Guy, 857 Rosecrans,  
San Diego, Calif.
- Philadelphia Terminals Auction Co., Del.  
& Wolf St., Philadelphia, Pa.
- Plummer, J. K., Atlanta, Ga.
- Pratt, Bernard D., Kapaa, Kauai, Hawaii
- Reuther, Walter, USDA Exp. Date Garden,  
Indio, Cali.
- Rutland, J. W., 413 Volunteer Bldg.,  
Atlanta, Ga.
- Schrader, Otto Lyra, c/o Nat'l City Bank  
of N. Y., N. Y. 15, N. Y.
- Shepherd, Don, Box 1083, Jerusalem,  
Palestine
- Showers, Byron J., 502 Security Bldg.,  
Phoenix, Ariz.
- Stark Bros. Nurseries & Orchard Co.,  
Louisiana, Missouri
- Swetland, Jr., Frederick L., San Francisco  
de las Piedras, Isla de Pinos, Cuba
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Council Barr Bldg., 910 17th St. N. W.,  
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- Tennessee Copper Co., Copperhill, Tenn.
- Tennessee Corp., Grant Bldg.,  
Atlanta 1, Ga.
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Br. P & Ma., Washington, D. C.
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- Waterston, J. M., Box 410,  
Hamilton, Bermuda
- Wolf, Frederick A., Durham, N. C.
- Yee, Warren, Wailuku, Maui, Hawaii



# PROCEEDINGS OF THE FLORIDA STATE HORTICULTURAL SOCIETY, 1947

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VOLUME LX

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*Text of Addresses*  
*Delivered at*  
*60th Annual Meeting*  
*Florida State*  
*Horticultural Society*





## PRESIDENT'S ADDRESS

F. M. O'BYRNE

*Lake Wales*

This is the first year that our regular annual meeting occurs in the fall instead of the spring. Each season has its own advantages. We ask that our members evaluate the merits and demerits of a fall meeting and give us their opinions. It is your Society, and we wish to meet at the time which suits you best.

At its last meeting, your Society called upon our State and Government agencies to finance and push with all possible speed the investigation of the Tristeza disease of citrus, which attacks trees on sour orange stock.

Due to Dr. Camp's presentation of the problem in Texas and largely through the efforts of E. M. Goodwin, a large grower of Mission, Texas, the interests there raised \$20,000.00 to help finance the campaign. The State Plant Board of Florida allotted \$2,000.00 from its emergency fund for this purpose.

In June of 1946, your officers made a trip to Tallahassee and presented the matter to Governor Millard Caldwell and his Budget Commission. Due to the keen interest and support of Commissioner-of-Agriculture Nathan Mayo, and on his motion, the Budget Commission approved the transfer of \$20,000.00 from his General Inspection Fund to the State Plant Board to help finance the investigation.

Due to the exactness required of State Expenditures, we felt that we should have a revolving fund raised from the Citrus industry for use in meeting promptly pay rolls and bills incurred in South America until such time as they could be put into proper shape for payment by the Comptroller. The leaders of the industry were acquainted with the situation and contribu-

tions solicited. From this source, we realized \$16,070.00. Officers were elected from the contributors and the funds placed at the disposal of Dr. A. F. Camp, Director of the Citrus Experiment Station. The investigation is progressing favorably and will be reported upon in detail at this meeting. We feel that your Society has been of great service to the Industry in this particular matter.

During the past summer, your President made a trip to Louisiana, Texas and Mexico. The groves in Louisiana sell practically all their fruit in New Orleans and so hardly affect us. There will be no great increase in plantings there.

The groves in Texas, on the whole, look fine, though there are occasional bad spots due to lack of drainage. During recent years, their plantings have run much more heavily to oranges than formerly. A few years ago, they were planting mostly Ham-lins and now they are planting heavily to Valencias. They are also continuing to plant Ruby Red grapefruit.

The soil in Texas is heavy and they can raise vegetables or cotton between the tree rows for the first three years, very largely defraying the cost of raising the grove.

Their production costs are lower than ours, due principally to their using less fertilizer than we do and also to the fact that they have been getting all the Mexican labor they wanted for twenty-five cents an hour plus a house. Mexicans able to drive a truck or tractor get slightly more. When you think that we pay sixty-five cents per hour for common labor, you can see where much of the difference in care costs lies. Since my return, Mexico has raised the price on this labor five cents per hour, so that eventually our care costs may tend to become equalized.

The Texas growers are doing no oil spraying, believing that they can get by with natural controls. I saw three groves rather badly infested with scale. The time may come when they will have to spray with oil. They control rust mites by dusting, mostly by airplanes.

Their main headache is their irrigation water. Mexico is cutting off some streams of good, fresh water and using it locally. The concentration of salts in the Rio Grande is increasing. During periods of drought, the salt concentration in the grove soils becomes high and the trees suffer until a heavy rain comes and flushes the salts out of the soil. They had a very heavy rain just before I arrived. They are now planning a master drainage system, as well as a larger irrigation system. They feel that this will permit them to reclaim some soil which is now unsuited for citrus.

Texas grove values went up at the same time ours did, but not quite as high. They dropped when ours did and none of them were bragging about the amount of money they made last year. Still and all, it looks to me as if they would be in the business for a long time to come.

There are many acres of young grove just planted. I did not learn if these plantings were real estate promotions or additional acreage planted by owners of bearing groves. My guess is that Texas has almost as many groves planted as the Rio Grande will irrigate. They have plans for the development of many more acres northwest of their present plantings. How they hope to get irrigation for these groves, is beyond me.

The groves in Mexico are likewise on heavy soil. They look fine and were carrying ripe Valencia oranges the last of August. There was no drying or crystallization at the stem-ends in any of the fruit I purchased. The fruit was almost too sweet.

There are many groves that have just been planted. Fully fifty per cent of the citrus groves I saw in Mexico are below

bearing age. Of the bearing groves observed, fully eighty per cent are young groves and but twenty per cent are of any considerable age.

The groves I saw were well cared for with modern machinery, International tractors and such equipment. The trees are on sour orange stock and are quite vigorous. Many groves were carrying a second bloom the last of August. I called on Government Agricultural officials, asking the extent of the new plantings. They could give me no figures, but said they were very large.

All of the Mexicans to whom I talked seemed to think they would have no fruit to export. I can not see how they can fail to have a surplus for with their present plantings. I was able to buy fresh orange juice everywhere I went in Mexico. I do not see how they can possibly absorb all the increased production that I saw in sight. Will the State Department want the United States to admit this Mexican fruit in furtherance of the Good Neighbor Policy?

There is one thing that I would like to stress. From the time I reached "The Valley" in Texas, all the way through Mexico and back through "The Valley" again, I could get freshly squeezed orange juice at any time. It was *offered and pushed*. In a McAllen, Texas, hotel, I was told that the only fruit juice they could give me was fresh orange juice. Likewise, throughout Mexico, I could get fresh orange juice in every town of any size. It was not poured out of a can, nor had it been squeezed out a couple of hours before and grown flat and tasteless. It was often squeezed before your eyes.

It makes my face red when I recall tales told me winter after winter by visitors to my home town, who say they had to take canned orange juice or go without. We growers should look into the situation in our home towns to see to it that visitors asking for orange juice can always get freshly squeezed orange juice in our hotels, restaurants and drug stores. I feel that

the growers have done a much better job in Texas and Mexico in securing the co-operation of their hotels and drink shops. Even the Mexican radio commercials featured "naranjas."

Many years ago, Congressman Drane reported that Mr. Goodall, who manufactures all of the Palm Beach clothes and ties, asked him if citrus growing was a profitable industry. Congressman Drane, to Mr. Goodall's surprise, replied that citrus growing was not an industry. Mr. Goodall said, "Well, if citrus growing is not an industry, what is it?" Congressman Drane replied, "It is a disease. You either have it or you don't. Those who have it are to be pitied, for they go right on raising citrus, even when they may lose money doing it."

Subsequent to that conversation, the citrus industry has enjoyed some wonderful seasons, but last season brought us back to conditions that Congressman Drane had in mind. Almost everything that could happen to depress citrus prices occurred. Many of the depressing influences were beyond our control, but many of them are not. Where controls are available, we should apply them.

First, we should try to see that we have no such large carry-over of canned citrus juice as we had last fall. A large carry-over will always depress prices.

Second, we need to give more attention to quality and less to quantity. The market will always absorb more good oranges than it will poor oranges. We have been straining to produce as many boxes per tree as possible. Let us concentrate on producing good fruit.

Third, we need in some way to reduce the number of sales agencies offering Florida fruit for sale. The buyers constantly play one sales manager and his quotations against the other and beat prices down. Buyers in the North buy sparingly when the market is weak and apt to break even further. A strong and rising market helps everyone. California demonstrates year

after year the great advantage of fewer selling agencies.

Fourth, we as producers must realize that any decay that occurs in our fruit comes out of the grower's pocket. Many think that they handle the fruit so that it reaches the jobber with little or no decay, the grower's interest is over. This is a mistake. If decay is heavy in the fruit before it is consumed, occurring in the hands of the wholesaler, retailer or housewife, it will result in many switching to fruit grown in dryer regions, where decay is not so heavy.

Florida fruit has rightly been called "Balls of Juice." Such fruit will decay unless it is very carefully handled. During the war, most of our houses switched from clipping fruit to pulling it. The pickers prefer to pull fruit and some will tell you there is less decay in pulled fruit than when it is clipped. This may be true when pulled by an expert, with care, but when the ordinary picker pulls fruit, he is interested in speed and not in care. A picker in a hurry should always use clippers.

Last year, a grower was checking the picking of a crop in another grower's grove. The fruit had been purchased "on the tree" by an independent buyer. As soon as the boss left, the pickers put up their clippers and started to pull the fruit. The checker protested, without results. He made the mistake of thinking it was none of his business as it was not his fruit and had been bought "on the tree." Soon the pickers were picking the fruit and dropping it to the ground, then picking it up in sacks and emptying it into the field boxes.

No wonder that this fruit decayed badly before it was consumed. Most of the decay showed up on the sides of the fruit. Such handling of fruit hurts every grower in the State, for no matter how carefully your house handles your fruit, it is bound to be penalized considerably because of rough handling by other houses.

We growers should see to it that we grow the highest quality fruit that our



groves are capable of producing and that all fruit is handled like eggs from the tree to the car and then on to market. Any decay which occurs before that fruit is consumed, means money out of our pockets. Believe it or not!

We are going to see higher and higher

production in the years to come. Competition will be more and more keen. It is up to us to see that Florida fruit is handled right, handled carefully and sold to the best possible advantage. Otherwise, we will have the disease of citrus growing and be in very hopeless shape.

## THE RELATION BETWEEN THE HORTICULTURIST AND HIS BANKER

T. G. MIXSON, Pres.  
*First National Bank*  
St. Petersburg, Florida

Mr. President, Honorable Guests, and Members of the Florida State Horticultural Society.

I am honored to be accorded a place on your program. It is a privilege to be associated with you in my capacity as Chairman of the Citrus Committee of the Florida Bankers Association—as banker to some of you, and a pleasure to see many of my friends among you.

I am intensely interested in the aims of your organization and the contribution you are making to the economy of our state. You have gone far in the production of quality products and their distribution. You have done an outstanding job in research—producing more and more consumer products and yet there is more to be done when we are faced with mounting volumes of production from year to year. We have seen in the past year and a half, fruit—both fresh and canned—in excess of what the market might consume on a profitable basis, based on temporary conditions prevailing at the time. I am frank to say that I do not have the answers to these problems and sometimes have almost doubted whether you have them—notwithstanding the wonderful progress you have made in the past twenty-five to forty years.

Although our Bankers' Association has

had a Citrus Committee for years, I do not know of any constructive cooperative effort which has developed between our association and your several organizations or agencies. Let me stress however that individual banks and bankers have taken an active part in your problems and I believe have made outstanding contributions to the industry.

During August of this year, our committee composed of officers of many of the outstanding banks in the Citrus area met in Lakeland and after mature thought, adopted the following statement of policy.

### STATEMENT OF POLICY

The Florida Bankers' Association through its Citrus Committee recognizes that the citrus industry is foremost in the economy of the state. It is further recognized that there is an ever increasing supply of citrus and because of this the industry is faced with serious problems in marketing and distribution. The Florida Bankers Association therefore is vitally interested in and is anxious to cooperate in improving these conditions.

It has been observed with interest and gratification the thought, study, and intelligence which are being given to the solution of these problems by the Florida Citrus Commission, citrus trade bodies, and canners especially as related to the movement of immature fruit and further improvement of the standardization of quality both in fresh and processed fruit.

It is believed the solution of these problems requires the unselfish cooperation of all parties interested in the citrus industry. The marketing of the increased production lies in a wider distribution and more favorable acceptance by the ultimate consumer. It is felt that increased thought, study and research should be given to production of better quality fruit, perfection of processing and merchandising methods and development of new consumer products.

Because of its sustained interest in the development of the citrus industry, the Florida Bankers' Association reaffirms its desire and willingness to render every possible assistance to growers, processors, and distributors, and their affiliated organizations.

\* \* \*

Copies were sent to the key organizations in order to acquaint you with our interest in the industry. It is felt that the Citrus Committee through the Florida Bankers' Association might exchange ideas, and from these meetings find the answers to the knotty problems which lie ahead.

Fortunately, for the industry as a whole we had a freeze in the early spring which gave buoyancy to a sagging market and the industry had a fair year. In the face of this, press reports have indicated that we had a sizable volume which was not marketed by reason of an unusual amount of drops and grapefruit which had no market.

You are plagued in almost every normal year with the shipment of fruit early in the season which you and I would not eat and after the consumer gets a taste you see the reaction in the market. I make this statement fully cognizant of the fact that competition is keen from other citrus producing sections and that it is a problem to move your production within a specific period.

Then we have speculation both in the fresh fruit and by the canner—You have to look no farther than the beginning of the past season to know of the disastrous

results which were visited upon the speculators and the industry also suffered.

Then we have the price cutter—both in fresh and canned fruit—he gets stocked up on merchandise in both forms—without first knowing where it is to be sold—and the result—price reductions and more suffering.

You are faced with another problem—that of a large number of shippers offering at varying prices when volume is heavy—in many cases resulting in losses to wholesale and retail distributors who have bought at relatively higher prices and then find it necessary to dispose of their stock at lower competing prices—These losses do not build with such distributors good will for Florida fruit, notwithstanding its top quality.

With the purchasing power of our country remaining for the current season at its present capacity. I think it is reasonable to expect the trade to consume our present crop at fair prices, provided it is quality goods. I advance this thought because of what was consumed last year with the market faced with the largest crop on record and seventeen million cases of canned goods overhanging the market. When those merchants and distributors who bought blindly in the 1945-46 season at high prices reduced to a reasonable level the public took the goods out of trade channels.

I hope that false moves will be cut to a minimum in the future.

Many of our banks are lending liberally in the production and marketing of canned fruit. Some are lending on groves. I have thought loans of this latter type might be expanded if we could ever get insurance protection against hurricane and freeze damage. However, no concrete progress has been made on the insurance program. This of course would make it more attractive to local banks—They should not take undue risks with yours and other customer's deposits. We do not have unlimited taxing power from which to receive ap-

propriations to make good the deficits to the capital account.

Some of our banks are now serving fresh and canned juice to all who visit their banking offices—thus popularizing your products. Our bank during the winter season keeps on display the products of most of the canners in the state for purposes of showing home folks and visitors some of the products our state produces and acquainting them with our canned citrus products, other fruits and vegetables and labels. Many of the 200,000 visitors to our city last year saw this exhibit.

While many of our merchants feature canned goods in their display advertising—there are many who do not. Why not contact those who do not and urge them to do so—they advertise prune juice, apple juice, pineapple juice, and tomato juice.

I have been impressed with the progress

made by the vegetable growers in the production of quality products—In the relative past few years their distribution has improved immeasurably. I still feel that much can be done by that unit in grading and packaging—taking care that the culls are fed to livestock, thus offering the best grades for consumption and improved prices.

Let me urge you, whether it be citrus—specialties or vegetables to refrain from pricing yourselves out of the market

In conclusion, even though I may not have covered all the phases of the industry, nor those referred to completely. I trust that what I have said has some merit. Your bankers are keenly interested in what you are producing and marketing for it means so much to you and the economy of the state.

I have enjoyed being with you on this occasion.

## GRADUATE WORK IN HORTICULTURE AT THE UNIVERSITY OF FLORIDA

By H. S. WORTH

*Department of Horticulture*

University of Florida, Gainesville, Fla.

Horticulture has been for many decades the most important industry of Florida, but this fact has only slowly made its impress upon the educational system of the state. It was not until 1912 that there was a distinct and separate department of Horticulture in the College of Agriculture of the University, it having been treated previously as a phase of botany. Through the years since that time this department has devoted itself to training men for more effective participation in the production of citrus and other fruits, of vegetable crops and of ornamental plants. More course work in citrus culture is offered at the University of Florida College of Agriculture than in any other agricultural college in

the United States. We take a justifiable pride in the sound training we have given our graduates and in the prominent places they hold in the horticultural industry of our state.

Graduate work in horticulture actually antedates the establishment of a separate department. Since the first candidate for a Master of Science with a concentration in horticulture was so registered in 1905. The first M. S. degree for work in this field was given in 1909 to H. S. Fawcett, a man who later became the outstanding leader in the study of citrus diseases. Since his graduation, thirty-two men have received the M. S. degree for horticultural study and research, and have gone largely into teaching and research work in this state and in many foreign countries. In this graduate training the staff of the teaching department have enjoyed the warm and close cooperation of

the horticulturists on the staff of the Agricultural Experiment Station, and the research workers and facilities of the Station have greatly broadened the type and scope of the research problems available for pursuit by candidates for the Master's degree.

With the expansion of the research work carried on at the branch stations, there has been an increase of staff until now some of these branches have a larger staff of skilled research men than the Main Station had 20 years ago. We are particularly interested today in the situation at the Citrus Experiment Station with the tremendous expansion of which in the last few years you are familiar in some degree. The Board of Control has recently, with the full approval of Director Mowry and Vice-Director Camp, made it possible to utilize the facilities of the Citrus Station and its staff for instructional purposes. It is now possible to have students work out the thesis research for the M. S. degree at the Citrus Station, where facilities for research in many phases of citrus culture are much superior to those available at Gainesville. Furthermore, a plan is being worked out which will permit graduates of the College of Agriculture with a horticulture major and special emphasis in citrus culture to intern, as it were, for a semester or a year at the Citrus Station. This period of practical experience in the best modern grove, packinghouse or processing procedures should be a valuable adjunct to the sound training in basic principles and the limited practice in operations which are considered sound educational procedure.

The way is now open for a further step in horticultural graduate training. It is a great pleasure to say that in the near future we expect to announce that by reason of this same effective cooperation, the Ph. D. degree may be obtained in horticulture at the University of Florida. The research program of our Agricultural Experiment Stations has been greatly expanded in recent years, both in the field of citrus and in that of vegetables. There are at least 6

or 7 men working in each of these broad fields who are fully qualified to direct the research work of candidates for the doctorate. Many other universities in this country give the Ph. D. degree in horticulture with a concentration in vegetable crops, but only our great rival state in citrus production offers a Ph. D. to horticulture students specializing in the citrus field. California has trained many research men for her own service and for other subtropical countries, and Florida will now be able to do the same. Already we have a young man from India who plans to work for a Ph. D. in horticulture, specializing in citrus production.

Facilities and staff at our Citrus Experiment Station are so well developed that a candidate for the doctorate may carry on research in any one of three separate areas: citrus production, citrus fruit handling, or citrus processing. The extensive experimental groves of the Station, as well as the thousands of acres of commercial plantings within a few miles of the Station and available for cooperative research use, together with the splendid library and laboratory facilities of the Station, afford ample scope for research in citrus production. The new research packing-house at the Citrus Station, together with the same library and laboratory facilities, assures proper opportunity for students to carry on advanced research in the handling of citrus fruit to best advantage. And the excellent new building for research in processing problems of citrus fruits, together with the big commercial processing plants located in Polk and adjacent counties, offer unrivalled facilities for thesis research in this important citrus field.

On the vegetable crops side, there is a new processing laboratory nearly completed at the Main Station at Gainesville, and both there and at Bradenton are fields and laboratories for research in production of vegetables. Mention may also be made of the fact that this year for the first time it is possible to offer undergraduate courses

in the processing of fruits and vegetables, so that there can be a sound basis for work on the graduate level.

The various physical facilities which I have mentioned as suitable for use in research by candidates for a Ph. D. would be of small value without properly trained and experienced research men to direct the work. We can take pride in the calibre of the research workers on our Station staffs. And the fact that they are busy with investigation of problems important in the citrus and vegetable industries makes it possible for doctoral candidates to select genuinely practical problems for their thesis research too.

I have stressed mainly the research facilities of the Agricultural Experiment Stations, because these are exactly the facilities which the Department of Horticulture of the College of Agriculture does not have in amount sufficient to permit work on the doctoral level. But we have the teaching resources of all the other agricultural departments of the College to supplement our own in the necessary courses to prepare a man for advanced research in horticulture, and this combined with the research men and facilities of the Stations makes possible this latest advance in the training of men for horticultural service in Florida.

## CITRUS SECTION



# A PRELIMINARY REPORT OF WORK AT CAMPINAS, BRAZIL, ON TRISTEZA DISEASE OF CITRUS

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In September, 1946, work was started at Campinas, Brazil, on the disease of citrus known as tristeza, with the hope of contributing information on the nature of the disease, its method of spread, its host range including susceptible scion-stock combinations, and on control. This work was initiated, and is being continued, as a joint cooperative project between the Instituto Agronomico of the State of Sao Paulo, Brazil, and the Division of Fruit and Vegetable Crops and Diseases of the United States Department of Agriculture. This paper reports the progress of the work during the first year.

## ECONOMIC IMPORTANCE AND SYMPTOMS OF THE DISEASE

In South America tristeza appeared first in Argentina about 1932. In Brazil it was found first in the Parailba Valley in the State of Sao Paulo in 1937 and within a period of 10 years it spread to all of the major citrus-producing areas of the country and has killed or rendered unprofitable a high percentage of the trees of the standard varieties of sweet orange on sour orange stock.

On bearing trees first signs of the disease

often appear on one side of the tree and soon spread to all parts of the top. Leaves are slightly bronzed, or otherwise discolored, and more brittle and leathery than those of healthy trees. In some cases there is a distinct yellowing of the midrib, the midrib and lateral veins, or even the entire leaf. Soon many of the older leaves fall. Lateral buds start growth and produce short, weak shoots with small leaves. Usually the first year after the disease appears the tree blossoms heavily and sets a large crop of fruit which is very conspicuous when ripe, partly because of the sparseness of the foliage. Trees decline rapidly in vigor. Twigs die back from the tips and sprouts are produced from the main limbs. Yields are drastically reduced after the first or second year and the trees are of little value.

## TRANSMISSION TESTS

Experiments have been made to transmit the tristeza disease from affected plants to healthy plants of known susceptible scion-stock combinations, both in the field and in the greenhouse, by various methods available for such transmission

## FIELD TESTS

In the first test for transmission of tristeza to nursery trees, 20 trees of the variety Bahianinha on sour orange stock were selected from a nursery near Limeira and planted in plots near Campinas, October 31, 1946. Ten of these trees were inoculated November 20, 1946, by placing 2 buds from diseased trees into each plant. The trees were reinoculated December 18, 1946. The 10 trees remaining were held as checks and were not inoculated. All of these trees came from a nursery in an area where tristeza was prevalent and it was recognized that



some of the trees may have been infected before inoculation. One of the check trees began to produce yellow leaves by January 15, 1947, and showed other symptoms characteristic of tristeza. By June 1 all of the 10 inoculated trees and 3 of the check trees showed rather marked symptoms of tristeza. All of these diseased trees blossomed and 9 of the 10 inoculated trees set fruit which matured in September. The 7 healthy-appearing trees on October 1 were consider-

should be free of the disease. All of the trees were on sour orange stock. One-half, or more, of the trees of each variety was inoculated with buds from diseased trees January 18, 1947, and reinoculated April 9, 1947.

By the first of May, or approximately three and one-half months after the first inoculation, some of the inoculated trees of the variety Barao began to produce symptoms characteristic of tristeza. About a

TABLE 1—RESULTS OF INOCULATION OF NURSERY TREES IN PLOTS AT FAZENDA SANTA ELIZA, CAMPINAS, WITH BUDS FROM DISEASED TREES

Variety Tested	Number of trees used in test	Trees inoculated		Trees used as checks	
		Number	Number diseased	Number	Number diseased
Bahianinha*	20	10	10	10	3
Barao	25	15	10	10	0
Seleta	25	15	13	10	0
Pera do Rio	20	10	9	10	0
Abacaxi	10	5	0	10	0
Parnasia	10	5	5	5	0
Serrana	10	5	4	5	0
Campista	10	5	5	5	0
Lima	10	6	4	5	0
Coronel	10	5	5	5	1
Mangaratiba	10	5	3	5	0
Bahianinha	5	5	5	—	—

\* These trees were planted October 31, 1946, and inoculated November 20, 1946, with buds from diseased trees; they were reinoculated with buds from the same source December 18, 1946. All other trees were planted the first week in December, 1946, and inoculated January 18, 1947, and reinoculated April 9, 1947. The above records were taken October 1, 1947.

ably larger than the inoculated trees, had normal foliage, had blossomed sparsely, and had set no fruit.

In a second field test trees of the varieties Barao, Seleta, Pera do Rio, Abacaxi, Parnasia, Serrana, Campista, Lima, Coronel, Mangaratiba, and Bahianinha were obtained from a nursery near Santa Rita the early part of December, 1946, and planted at Campinas. At the time the trees were selected tristeza was only just beginning to appear in the area around Santa Rita and it was thought that most of the younger trees

month later some of the inoculated trees of the variety Seleta began to show abnormal coloration of the foliage. Symptoms characteristic of tristeza appeared on other varieties until by October 1, as indicated in table 1, most of the inoculated trees of all of the varieties except Abacaxi, were obviously abnormal. These abnormalities consisted chiefly of stunting of the trees, production of various shades, types and degrees of yellowing of the foliage, dropping of leaves, and profuse blossoming. Leaf cast was severe on some of the trees of the

varieties Barao and Mangaratiba and was especially severe in the case of the inoculated trees of the variety Coronel. Leaf dropping was followed by the production of many weak axillary shoots. With the exception of one tree of the variety Coronel which lost most of its leaves, blossomed heavily, and was obviously diseased, none of the check trees of any of the varieties have shown symptoms characteristic of tristeza.

#### GREENHOUSE TESTS

An extensive series of transmission tests has been made in greenhouses screened to give a considerable degree of protection against insects. Most of these experiments were made with small plants 4 to 24 inches tall growing in pots. Each of the small plants used for inoculation was produced by grafting a sweet orange top on a sour orange root when the plants of sweet and sour orange were only about 3 inches tall.

*Inoculation with Twigs and Buds.* Since all virus diseases are transmissible by graft, the first attempts to transmit the tristeza disease were made by grafting twigs and buds from diseased plants onto healthy plants. In one of these tests, small healthy plants were approach-cleft-grafted to twigs of diseased trees growing in barrels in the greenhouse. After a contact period of about 30 days the diseased twigs were severed just below the point of union with the healthy trees and allowed to continue to grow on the inoculated plant. Of 28 trees inoculated in this manner, 21 have shown definite symptoms of tristeza. Of 10 trees grafted with twigs of healthy seedling orange plants, none has shown symptoms of disease.

In a modification of the method of inoculation just described, twigs were taken from diseased trees and approach-cleft-grafted into the stems of healthy trees. The cut ends of the twigs from the diseased trees were kept in vials of water until union was complete and then severed just below the area of contact with the inoculated tree. This method of inoculation has given a

relatively high percentage of infection with twigs from known disease sources, and little or no infection from certain other sources.

Several experiments have been made in which buds from diseased trees were placed in the stems of healthy plants. So far this method of inoculation has given a very low percentage of infection when used with small potted plants.

In all cases of infection in these experiments in which inoculations were made by the grafting of diseased tissue to healthy plants, symptoms have begun to appear in periods varying from 30 to 90 days. Usually first signs of the disease appear in the youngest leaves. These are somewhat more yellow than normal and soon growth is retarded and the older leaves of the plant become pale, pale yellow, or yellow. The degree of yellowing varies greatly with different plants, but the degree of stunting is more or less uniform. Some plants have remained yellow and stunted for more than four months; others have produced some additional growth with more or less normally colored leaves that are smaller than those of healthy plants. Leaves have fallen from some of the more severely affected plants.

*Inoculation with Insects.* Small citrus plants composed of sweet orange tops on sour orange roots have been inoculated with most of the species of insects with sucking mouthparts that have been found feeding naturally on citrus plants in the plots at Campinas, and with certain other species of insects that have been induced to feed on citrus plants. These insects have consisted of 5 species of leafhoppers, one species of whitefly, and 6 species of aphids, including the black citrus aphid of Brazil, *Aphis citricidus* Kirkaldy.

Only plants that were inoculated with the black citrus aphid have shown symptoms of yellowing and dwarfing characteristic of tristeza. In all experiments in which this aphid was transferred from diseased to healthy plants in large numbers, a high percentage of the inoculated plants has later

shown symptoms of the disease. Usually the inoculated plants began to produce yellow leaves at the growing tips about 30 to 60 days after inoculation. Growth was much retarded and the plants showed various degrees of yellowing. In some cases the older leaves turned bright yellow in color and some leaves dropped. In other plants yellowing was less marked and in some cases the leaves were only slightly paler than those of normal plants. A few plants of this latter type have produced new shoots with small leaves more or less normal in color. Check plants infested with approximately the same number of aphids from healthy plants have remained normal in all cases. In some of the earlier experiments the check plants are now 3 to 4 feet tall, whereas the inoculated plants are pale to very yellow in color and average only about 12 inches tall.

These results with the black citrus aphid of Brazil are similar to those obtained by Meneghini<sup>1</sup> in tests with this insect. The evidence now available seems sufficient to justify the conclusion that the black citrus aphid, *Aphis citricidus*, is an agent of transmission of the tristeza disease in Brazil.

*Inoculation with Sap from Diseased Plants.* In tests of transmissibility of tristeza by means of juice, sap was pressed from young succulent shoots of orange trees that had been diseased for more than two years and which showed marked symptoms of tristeza. The juice was then used immediately to inoculate small rapidly-growing orange trees. The inoculations were made by rubbing the juice over the surface of the leaves that had been sprinkled with an abrasive before inoculation. Forty trees were inoculated in this manner and 10 trees were retained as checks. Five months after inoculation no symptoms characteristic of tristeza were evident on any of the inoculated or check trees.

Attempts have been made also to transmit tristeza to annual plants by means of juice inoculation. Obviously, if a type of annual plant susceptible to infection and producing marked symptoms, could be found, such a plant would be extremely useful in further studies on the tristeza disease, particularly in the determination of the presence of virus in different species and varieties of citrus on which no evidence of infection has so far been recognized and in detection of early stages of infection in trees of sweet orange on sour orange stock. However, although some 50 species and varieties of annual plants have been tested, none has shown abnormalities that have been attributed to the tristeza virus.

*Tests for Seed Transmission.* All of the seedling plants of both sweet and sour orange used thus far in the work on tristeza at Campinas have been produced from seeds from diseased trees or from trees that have been exposed to infection over a considerable period. A total of over 1100 plants composed of sweet orange seedlings grafted on sour orange seedlings has been prepared. Some of these have been inoculated by grafts or by the black citrus aphid and have shown the disease, but only after a reasonable period of time following inoculation. More than 325 plants, however, have been held as checks or have been inoculated by juice, by dodder, or by means of insects that appear not to be vectors of the virus. Only one of these plants has shown symptoms characteristic of the tristeza disease. This plant was not inoculated. Symptoms have persisted for more than four months but it has not been determined by inoculation tests that the plant carries the virus. It should be emphasized, however, even if this plant proves to be infected, that this cannot be accepted as conclusive proof that the virus was transmitted through the seed since possibility of accidental infection by aphids is difficult to avoid in tests of this type, and more evidence must be available before definite conclusions may be reached. From the results obtained thus far it seems prob-

<sup>1</sup>MENEGHINI, M. Sobre a natureza e transmissibilidade de doença "tristeza" dos citrus. *O. Biologico* 12:285-286. 1946.

able, however, that the virus is either not transmitted through the seeds of sweet and sour oranges tested or, at most, it is transmitted through a very low percentage of such seeds.

Additional and more extensive tests are now under way to obtain further evidence on the problem of seed transmission. For these tests seeds were collected from trees of the variety Pera in advanced stage of disease. Sour orange seeds were harvested from trees on their own roots showing no obvious symptoms of tristeza but surrounded by badly diseased trees of sweet orange. The seeds of the two varieties of oranges were planted in flats. When the seedlings attain sufficient size the sweet orange seedlings will be grafted onto the sour orange seedlings and the resulting plants will be watched for appearance of symptoms of disease. Symptoms of tristeza should appear in plants of this combination if the virus is carried through the seeds of either the sweet or sour orange which give rise, respectively, to the scion and stock of the test plant.

#### SCION STOCK COMBINATION SUSCEPTIBLE TO TRISTEZA<sup>2</sup>

All trees of the varieties Pera, Balua, Bahianinha, Barao, and other sweet varieties of orange, when grafted on sour orange stock, seem to be susceptible to tristeza. The disease has been reported also on mandarin on sour orange stock. In tests of different types of stocks being conducted at the Citrus Experiment Station at Limeira, Brazil, by Senhor Silvio Moreira, trees of the variety Pera on grapefruit stock are dwarfed and show symptoms more or less characteristic of tristeza. The trees, however, have not declined so rapidly as trees of this variety on sour orange stock. Certain varieties of

tangelo on sour orange stock also appear to be susceptible to the disease. However, a strain of the variety Sampson appears to be resistant. Trees of Marsh Seedless grapefruit on sour orange stock also show symptoms characteristic of those produced by tristeza.

The common varieties of sweet orange in Brazil when grafted to sweet orange, rough lemon, Rangpur lime, sweet lime, ponderosa lemon, "cravo" tangerine, citron, and trifoliolate orange have been resistant. However, citron and trifoliolate orange have proved to be of little value as stocks.

Although certain scion-stock combinations seem to be required in order to have trees show symptoms so far recognized as characteristic of tristeza disease, it has seemed reasonable to suspect that certain types of citrus trees, both on their own roots and on various types of so-called immune stocks, might be capable of harboring the virus which causes the disease, and thus might serve as sources of infection without showing symptoms of the disease.

To obtain information on the possible host range of the virus an extensive test is being conducted in which as many as possible of the different varieties and types of citrus trees growing in areas where they have been exposed to infection over a period of years, are being tested for presence of the virus. Inoculations by buds, by twig grafts, and by aphids are being made from each source. Thus far transmission of the disease has been obtained from an unidentified citrus tree on its own roots, from the "cravo" tangerine on its own roots, and from the Pera variety of sweet orange on Rangpur lime. None of these three types of trees showed the severe types of symptoms recognized as characteristic of tristeza. Transmission has been obtained also from grapefruit trees on their own roots that showed marked yellowing of veins and yellowing of the entire leaf in the case of some of the twigs produced during periods of rapid growth. It seems evident from these results, therefore, that the casual virus

<sup>2</sup>The authors are indebted to Silvio Moreira, Chief of the Department of Horticulture of the Instituto Agronomico, Campinas, Brazil, for information on varietal susceptibility, and for the privilege of making observations on the effects of tristeza on trees on different stocks in the extensive stock tests at Limeira.

is not limited to trees that show symptoms, such as those that occur on trees of sweet orange on sour orange roots, but may occur in at least certain trees on their own roots or on stocks other than sour orange, in which no symptoms or only questionable symptoms of the disease have been recognized.

#### TESTS OF STOCKS FOR RESISTANCE

Experiments are being made at Campinas in which all of the available varieties and types of citrus and citrus relatives are being tested for their reaction to tristeza disease when used as stocks for sweet orange. Thus far seeds of 125 varieties and types of citrus and citrus relatives have been forwarded to Brazil by F. E. Gardner of the U. S. Subtropical Fruit Station at Orlando, Fla. These seeds were germinated in flats and at present plants of 119 types are growing in nursery rows and will be budded to sweet orange, probably in January. After the sweet orange buds have grown into shoots they will be inoculated with tristeza. Later the trees will be planted out 3 1/4 feet apart in rows 6 1/2 feet apart in locations exposed to further infection by tristeza and watched for appearance of symptoms of the disease. This test in the course of a few years should furnish valuable information on the degree of resistance to tristeza of a large number of citrus types when used as stocks for standard varieties of sweet orange.

#### SUMMARY AND CONCLUSIONS

The evidence now available seems ample to justify the conclusion that tristeza disease of citrus in Brazil is caused by a virus

which can be transmitted from diseased to healthy plants by means of buds or twigs and by means of the black citrus aphid, *Aphis citricidus*. The virus probably is not juice transmissible and as yet there is no conclusive evidence that it is transmissible through seeds of diseased plants.

Probably the chief natural agent of transmission of the disease in Brazil is the black citrus aphid. This insect occurs abundantly on the new growth in the spring and, despite the fact that it appears to be a very inefficient agent of transmission when compared with vectors of certain other virus diseases, it probably has been responsible for most of the spread of the disease in Brazil.

Tristeza causes severe damage to all varieties of sweet orange, to mandarin, and to certain varieties of tangelo when these types are on sour orange stock. There is evidence also that it causes severe injury to sweet orange on grapefruit stock and to grapefruit on sour orange stock.

In addition to these types of trees on which definite injury is produced, the virus occurs in certain kinds of citrus trees in which no symptoms have been detected. It has been recovered from an unidentified citrus seedling on its own roots, the "cravo" tangerine on its own roots, and from the Pera variety of sweet orange on Rangpur lime stock, none of which showed symptoms of the disease. It was recovered also from a seedling grapefruit tree on its own roots that showed a type of yellowing of leaves of rapidly growing twigs. These preliminary results indicate that the virus may be rather generally distributed in the various kinds of citrus trees in Brazil.

# SPREADING DECLINE OF CITRUS IN FLORIDA

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## INTRODUCTION

Within the past 10 to 15 years a diseased or declining condition has appeared in various groves. This condition is being called "spreading decline" because of the manner in which the trouble gradually spreads through a grove from a focal point of one or two trees that first showed the disease.

It has been reported (7) that there are 10 major causes for tree decline in Florida. Of these 10 causes, spreading decline is third in importance, being surpassed in prevalence by foot rot and root rot. Since this type of decline is a comparatively recent development and is becoming more prevalent each year, it is a serious threat to the groves of Florida. While most of the other causes of decline usually attack scattered trees in a grove, the spreading decline has a potential possibility of causing a whole grove to go out of production over a period of several years.

Investigations were started in 1945 to determine the nature and cause of this type of decline and to develop measures for its control. Although the work has not been completed, sufficient results have been obtained to indicate the nature and probable cause of the spreading decline.

## SYMPTOMS

A spreading decline area in a grove shows certain characteristics. All of the trees in the declining area show the symptoms while there is a sharp contrast at the border of the area or margin with declining trees on one side and healthy appearing trees next to them on the other side. A map of a typical spreading decline area is shown in Fig.

1. A diseased tree gradually becomes weakened by loss of foliage coupled with a lack of new growth. Such trees bear no fruit of commercial value and show sparse foliage and many dead twigs and branches. Data show that the first visible symptoms of spreading decline appear in a healthy tree adjacent to the margin of the decline area at the time of the spring flush of growth. These symptoms are: a variation in the amount of new growth in which some

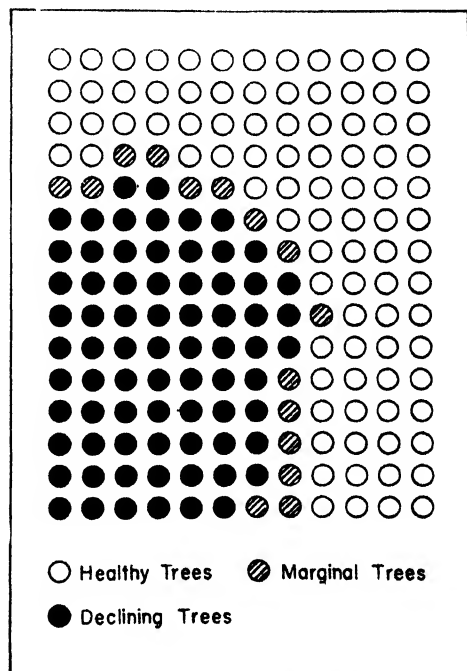


Figure 1. Map of a portion of grove No. 1 showing the typical localized distribution pattern for spreading decline.

trees produce no new growth at this time and others only a scattering; in others the flush is delayed 2 to 3 weeks; and in all cases there is a loss of a large percentage

of the older leaves causing the tree to have sparse foliage.

This decline of the tree is the effect of the condition of the roots. The root system shows a scarcity of fibrous or feeder rootlets and a certain proportion of the fibrous rootlets that are present have an abnormal appearance. These rootlets are distorted, stunted, thickened and have soil particles adhering to them that can not easily be shaken off. When such rootlets are examined the cortex readily comes off leaving the white woody cylinder of xylem tissue.

Trees which show spreading decline never die but usually maintain a weak type of growth. As long as there is sufficient

circulation during the past two years. The rate of spread of the decline in these blocks for 1945-46 and 1946-47 is shown in Table 1. The data show that the rate spread for 1946-47 was 64.5 percent greater than in 1945-46. One possible explanation for this difference is the fact that the spring of 1945 was exceptionally dry while the spring of 1946 was more nearly normal in the amount of rainfall. There was considerable variation in the rate of spread found in the various groves. Those groves which had received proper nutritional, spray and irrigation programs showed, in general, the lowest rate of spread. This condition will spread in any direction regardless of the elevation of the land.

TABLE 1.  
RATE OF INCREASE OF SPREADING DECLINE IN GROVES UNDER OBSERVATION

Grove No.	Increase in number of diseased trees per tree on margin of declining area	
	May 1945 to April 1946	April 1946 to May 1947
1	0.56	1.12
2	1.00	0.82
3	0.21	1.65
4	1.58	1.10
5	0.27	0.77
6	0.47	1.06
7	0.61	0.64
8	1.00	2.00
9	1.22	1.38
10	0.66	1.50
Average	0.79	1.20

moisture in the soil the foliage appears to be in good condition except that it is sparse. When adverse moisture conditions prevail, the spreading decline trees show a wilting condition while the healthy appearing trees adjacent to them show no wilting until the lack of moisture becomes critical.

Another characteristic of this type of decline is the gradual spread of the condition in the grove. A total of 10 blocks of trees have been mapped for decline oc-

#### OCCURRENCE

Spreading decline has been found on Hamlin, Parson Brown, Pineapple, Valencia and Temple varieties of orange trees, on Marsh and Duncan grapefruit trees and on tangerine trees. Grapefruit trees show a greater effect from the spreading decline than the other two kinds of citrus. The condition has been found on trees with rough lemon, grapefruit and sour orange rootstock. To date, spreading decline has

been found in 54 blocks of citrus trees. The trees have ranged in age from 9 to 50 years. There were 24 blocks of grapefruit, 27 blocks of oranges and 3 blocks of tangerines in which the condition was found. The location of the blocks in which the decline occurred was as follows: 44 in Polk County, 3 in Hillsborough County, 2 in Orange County and 1 each in De Soto, Highlands, Lake, Pasco and Pinellas Counties. A systematic survey of all citrus groves throughout the citrus areas in the state has not been made to determine the actual situation, but the data at hand gives a relative indication of the prevalence of spreading decline.

#### CAUSE

The peculiar condition of the rootlets found on the trees showing spreading decline might be caused by a fungus disease, a virus disease or by nematode infestation. In the experiments to determine whether the trouble was a fungus disease, several fungi (*Fusarium* spp., *Diplodia* spp., *Cephalosporium* spp., and a few unknown species) were isolated from the affected rootlets but none of them proved to be pathogenic. Also, there was no significant difference in the microflora of the soil in the declining area compared to that of the soil in the healthy area in four groves where an intensive study was made. Numerous experiments were conducted in which budding, grafting and leaf grafting tests were made to determine if a virus could be transmitted. So far there has been no evidence obtained which would indicate that the spreading decline is a virus disease.

Although it had been considered that a nematode might be associated with spreading decline, it was not until in November, 1946, that they were actually found. Since that time, examination of the abnormal rootlets from the 54 blocks under observation has shown that a nematode was associated with the condition in all cases. In 16 of the blocks typical female nematodes were found that identified the nematode as

*Tylenchulus semipenetrans* Cobb, the citrus nematode.

A survey of the available literature on the citrus nematode (1, 2, 3, 4, 5, 6, 8, 9, 10) gives the following information concerning this pest. The only known host of *Tylenchulus semipenetrans* is citrus and this nematode was first discovered in California in 1912. It was first found in Florida in 1913 and between 1914 and 1917 was found at Glen St. Mary, Gainesville and Brooksville. Today the nematode has been found in most of the citrus producing areas throughout the world. In Argentina, Mr. E. P. Du Charme who is on leave from the Citrus Experiment Station and who is working on the Tristeza Project at the Experiment Station, Concordia, reported that the citrus nematode was present in most groves and that the *Poncirus trifoliata* rootstock showed some resistance to nematode infestation (unpublished data).

The male and larval stages of the nematodes are worm-like and less than one-half millimeter long. These forms are usually free-living in the soil adjacent to the rootlets although they may feed on the outer layer of cells of the rootlet. The female penetrates the cortex of the rootlet with the anterior portion while the posterior part swells up and remains outside of the rootlet. Once the female penetrates the root it becomes fixed in that position for its life. The eggs are laid in the soil adjacent to the rootlet and hatch within two or three days. It requires about 6 to 8 weeks for a complete life cycle. The feeding of the nematode in the cortex results in a disintegration of the cambium region which causes the rootlets to become distorted, stunted and thickened. The infested rootlets eventually die. It is reported that the appearance of the tree is an indication of the amount of infestation of the roots. The citrus nematode has been found to exist in the soil for as long as three years without citrus being present and has been found in the soil to a depth of 6 feet in California. The nematode is usually introduced into a grove by plant-



ing infested trees and also may be spread by cultivation operations as well as irrigation water and rain. In California the effect of the citrus nematode on citrus is known as "slow decline."

A random survey of some groves in Florida indicate that the citrus nematode is quite widely distributed. As shown in Table 2, the nematode has been found in 10 of the 12 counties where samples have been obtained. Nematodes were found in all areas of spreading decline observed and *T. semipenetrans* females were present in 30 per-

cent of the areas. In the other location the nematodes found appeared to be male or larval stages of the citrus nematode. The healthy appearing trees around the spreading decline area also had nematode infestation. The nematodes have been found on healthy appearing trees in the same block as far as 500 feet from the area showing the decline but a study of the relationship has not been completed. It is possible that further tests will show the nematodes to be present throughout a grove which has a spreading decline area in one corner. It is also shown in Table 2 that nematodes have been found in 23 groves that do not have spreading decline. Of these 23 groves there were 9 in which *T. semipenetrans* females were found while in the other 14 groves the nematode count was very low. It is possible that, where nematodes are found in healthy groves, the infestation has not developed sufficiently to cause the spreading decline. There appears to be no definite time

TABLE 2.  
OCCURRENCE OF THE CITRUS NEMATODES IN GROVES EXAMINED

County	Number of Groves			
	With Spreading Decline		Healthy	
	Nematodes Absent	Nematodes Present	Nematodes Absent	Nematodes Present
Polk	0	44	26	11
Highlands	0	1	11	2
Lake	0	1	9	0
Orange	0	2	1	1
Hillsborough	0	3		
Sarasota	0	0	4	0
Osceola	0	0	1	0
Pasco	0	1		
De Soto	0	1		
Pinellas	0	1		
Manatee	0	0	0	6
Indian River	0	0	6	3
Total	0	54*	56	23**

\* Positive identification of *T. semipenetrans* in 16 of the groves.

\*\* Positive identification of *T. semipenetrans* in 9 of the groves.

cent of the areas. In the other location the nematodes found appeared to be male or larval stages of the citrus nematode. The healthy appearing trees around the spreading decline area also had nematode infestation. The nematodes have been found on healthy appearing trees in the same block as far as 500 feet from the area showing the decline but a study of the relationship has not been completed. It is possible that

limit on the occurrence of spreading decline. As previously mentioned the condition has been found in groves from 9 to 50 years of age. In one grove it is known that the trees have been infested with nematode for at least 11 years but show no decline symptoms in the above ground parts. Thomas (9) obtained decline symptoms in young trees that had been growing in pots of infested soil for 4 years. In another case

(4) field tests with young trees grown for 4 years in old citrus soil showed no decline symptoms but had grown only half as much as similar trees planted in virgin soil. This lack of growth has also been observed in young trees planted in an area where spreading decline trees had been removed here in Florida.

There are a number of facts which indicate that *T. semipenetrans* is probably associated with the spreading decline, although it may be that there are some factors which have an effect.

1. The nematodes have been found in all areas that show spreading decline.
2. In the soil extraction tests about 80 percent of the nematodes are the citrus nematode, which is approximately the same relation as found with the nematodes from the slow decline in California (4).
3. The abnormal appearance of the infested rootlets is identical with the illustrations and descriptions of citrus-nematode rootlet injury given in the literature
4. A *Fusarium* spp. was isolated most frequently from the abnormal rootlets and this fungus has also been reported as associated with slow decline in California (3, 4, 9).
5. Trees which show the spreading decline never die unless foot rot or some other disease is present. If the condition was caused by a fungus or a virus disease, it is probable that the tree would die. It appears that the tree is able to maintain a few healthy roots even though a large proportion of them may be infested with the nematode.

One characteristic of this type of decline which has not been reported in connection with citrus nematode infestation in other regions where citrus is grown is the gradual spread of the condition in a grove. Gen-

erally the decline is first observed in 1 or 2 trees and then gradually spreads in all directions from this focal point affecting every tree as it goes. Thus it would appear that the casual agent or agents is primarily spread by root contact from one tree to another. Because of this peculiar behavior of the decline it is possible that there are factors in addition to the citrus nematode that have an effect

#### CONTROL EXPERIMENTS

Before the probable cause of the spreading decline was determined experiments on control of the condition was of three types: severe pruning, tree injection and soil treatment in an effort to induce renewed growth. Approximately 500 trees have been treated in various ways. Some trees were cut back to 3/4-inch wood which removed all of the foliage, while other trees were buckhorned. During the season following pruning, the treated trees made excellent growth but during the second season the growth was retarded and the trees again started to show the typical spreading decline appearance. In some experiments solutions of different concentrations of 8-hydroxyquinoline sulfate, sulfanilamide and other similar materials were injected into the declining trees through the roots. No beneficial effect was obtained. Treatments have been made to the soil around declining trees to try to induce recovery and to the soil around healthy appearing trees adjacent to the decline area in an attempt to keep them from becoming diseased. Copper sulfate at 5 to 20 pounds, sulfur at 50 to 100 pounds, ammonium sulfate at 20 to 60 pounds, sodium chloride at 10 to 40 pounds, aluminum sulfate at 15 pounds, hydrated lime at 50 pounds and Dithane at 3 pounds per tree have been tried at various times and in different groves. None of the treatments caused any beneficial effects to the declining trees. Typical results from the treatments on the healthy trees adjacent to the spreading decline area are shown in Table 3 which is the data obtained from one experiment. None of the

treatments prevented the healthy trees adjacent to the decline area from becoming diseased within one to two years. Thomas (9) tried a total of 16 materials as soil treatments and obtained no control of the citrus nematode.

After it was established that the citrus nematode was associated with spreading decline, experiments were conducted to determine the effect of certain soil fumigants on the citrus nematode and on the trees. Injection of D-D (equal parts of 1,3 dichloropropene and 1,2-dichloropropane) into

excessive injury was caused by the 3, 4 and 5 ccs per square foot dosage while those treated with 2 ccs per square foot showed a shock from the treatment and were in poor condition on October 15, 1947, but may recover. It is doubtful if D-D can be used to treat the soil in which trees are growing.

Additional tests were made with Dowfume W-10 (10% Ethylene dibromide) and two Dow materials labelled S-991 and S-684. These materials used at 2 and 4 ccs per square foot were not as effective as the D-D for the control of the citrus nematode

TABLE 3.  
EFFECT OF SOIL TREATMENT ON THE CONTROL OF SPREADING DECLINE

Material	Pounds Per Tree	No Trees Treated*	No. diseased trees on		
			4/19/46	11/21/46	5/26/47
Copper Sulfate	10	34	9	10	31
Sulfur	50	35	1	6	31
Ammonium Sulfate	20	36	4	6	32
Non-treated	—	35	5	8	32

\* Treatments were applied in December, 1945.

the soil were made to a depth of 6 inches at rates of 2, 3, 4 and 5 ccs per square foot of surface area. Examination of the rootlets from the treated trees showed that all of the dosages had given control of the citrus nematode, at least in the top two feet of soil. Since the nematode is known to exist to depths of 6 to 8 feet under California conditions and to a depth of at least 3 feet in Florida, the higher dosages of D-D per square foot would result in more effective control. However, dosages of 2, 3, 4 and 5 ccs per square foot resulted in the death of the trees when the whole root area (625 square feet) was treated either in February or April. The trees treated in April died more rapidly than those treated in February. If only half of the root area (312 square feet) of the tree was treated,

However, at the 2ccs per square foot dosage there was apparently no serious injury to the trees.

It would be possible to control the citrus nematode by removing the declining trees and treating the soil with a fumigant. The area could then be replanted with young nematode-free trees. This has been reported (4) as the only treatment found to be beneficial wherever properly tried.

At the present time it appears that the citrus nematode is probably one of the factors responsible for the spreading decline in Florida. However the spreading characteristic of the decline has not been reported from other areas where the citrus nematodes occurs. Thus, it would appear that there may be other factors which have not been discovered at this time and which may be

responsible for the spreading condition. Further investigations will give some information on this point and will also determine whether a material can be found that will control the citrus nematode without serious injury to the tree. It is also possible that a rootstock may be found that is resistant or immune to infestation.

#### SUMMARY

Spreading decline has been increasing during the past 10 to 15 years and is now third in importance as a cause of decline in a grove. It occurs on grapefruit, oranges and tangerines budded on rough lemon, grapefruit or sour orange rootstock.

To date the condition has been found in 54 blocks of citrus ranging from 9 to 50 years of age. It has been found in 8 counties, but is most prevalent in Polk County.

The spreading decline is apparently not caused by a fungus or a virus disease but appears to be the result of the infestation of the rootlets by *Tylenchulus semipenetrans* (Cobb). The citrus nematode was also found in 9 of the 81 healthy groves examined and was found in 10 of the 12 counties where groves have been examined.

The average rate of spread of the decline in 1945-46 was 0.79 trees per tree on the margin of the declining area and in 1946-47 was 1.20 trees in the 10 groves which were under observation.

No control of the spreading decline was obtained by various types of pruning, tree injection with various chemicals in solution or by soil treatments with copper sulfate,

sulfur, ammonium sulfate, sodium chloride, aluminum sulfate, hydrated lime or Dithane. The citrus nematode was controlled by dosages of D-D at the rate of 2, 3, 4 and 5 ccs per square foot of area, but in practically all cases the trees were killed by this treatment, except when only half of the root area was treated with the 2ccs per square foot, in which case the trees lost considerable foliage but were not killed.

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# THE CITRUS SITUATION

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There are many angles to the citrus situation, but most of them can be grouped under four or five classifications—such as supply, demand, interrelation of supply and price, marketing, Governmental programs, and problems of the individual.

## SUPPLY

In the decade of the twenties world production of oranges averaged approximately 120 million boxes, United States production approximately 33 million boxes, and Florida approximately 10-1/2 million boxes. In the decade of the thirties world production averaged about 190 million boxes, United States production 60 million boxes and Florida production 21 million boxes. For the last five years world production has averaged approximately 230 million boxes, United States production 106 million boxes, and Florida production 50 million boxes.

From 1930 to 1935 most of the important world producing countries, except Spain, increased their production of oranges faster than the United States. From 1936 to 1946, because of wars and disease, production of oranges has not increased in any important orange producing country except the United States and Mexico. The increase has been much greater in Florida than in any other area.

In 1926-27 the United States produced approximately 31 percent of the world's oranges, in 1936-37 only 28 percent, but in 1946-47 about 51 percent. The dominant role Florida is acquiring in the United States and the world orange industry is shown in the following percentages: Florida produced in 1926-27 about 9 percent of

the world's total production, and about 28 percent of the production of the United States. In 1936-37 Florida produced about 11 percent of the world's oranges and about 41 percent of the oranges produced in the United States. In 1946-47 Florida produced about 22 percent of the world's oranges and 47 percent of the oranges of the United States.

In the case of grapefruit, the United States produced, in the 1924-25 season, only 10 million boxes which was 90 percent of the world's grapefruit. At this time (1924-1925) Florida was producing about 80 percent of the world's production. In 1935-36 the United States produced 18 million boxes, which was 88 percent of the world's production; and in 1946-47 the production of the United States was 62 million boxes, which was 95 percent of the world's production.

As compared to deciduous fruit production in the United States, bushel for bushel, orange production is about 1- 1/2 times the production of apples, about 2 times that of peaches, and about 5 times that of pears. Grapefruit production, bushel for bushel, is about 4/5 that of apples, slightly more than that of peaches, and almost 3 times that of pears.

Estimates of the United States or Florida production of oranges several years in the future have been, in most cases, entirely too low. No one can foresee wars, diseases, or price changes, or tell the effect these things will have on the production of oranges or grapefruit. It is my understanding that the bearing surface of orange trees in Florida is increasing at the rate of 5.7 percent per year and that of grapefruit 3.5 percent per year, however, crops cannot be forecast by projecting this percentage into the future.

If prices and political conditions will

permit, there will no doubt be a marked increase in the production of citrus fruit in the next few years in all important citrus producing countries, except for South American countries where disease is causing great damage. It is probable that those countries which have had their production adversely affected by the war will recover their production by the demand for citrus can be restored in Europe.

#### DEMAND

The per capita consumption of fresh oranges is very large—approximately 1.6 times as great as that of apples, 2 times that of bananas, 2 times that of peaches, 5 times that of pears, and 6 times that of grapes. Fresh grapefruit consumption is about  $1/2$  that of fresh apples,  $2/3$  that of bananas, only slightly less than that of peaches, and  $1/3$  more than that of pears.

The trend in the per capita consumption of citrus juices is still sharply upward; especially is this true for oranges. In the case of grapefruit juice, there is a tapering off of the rate of increase in the per capita consumption (Figure 1). The consumption of all citrus juices is approximately at the same level as that of tomato juice and of all other fruit juices combined. The rising trend in the per capita

consumption of citrus juices is decidedly greater than for other juices (Figure 2). Because the cost of marketing citrus juice is less than for fresh citrus products (for equivalent food value), the increased trend in citrus juice consumption may be expected to continue its upward trend for some time.

The possibility for increased uses of canned citrus segments should not be overlooked. In Figure 3 is given the per capita pack of peaches, pineapples, pears, apples and grapefruit. It will be observed that the per capita pack of grapefruit is very low as compared to that of other fruits. orange segments are, of course, only beginning to appear on the market. Because orange and grapefruit segments compete very little with canned juices or fresh fruit this is a fertile field for expansion. The volume of citrus juices packed is approximately as great as that of tomato juice and all other juices combined, but the pack of citrus segments is only 5 percent of the total fruit pack. Should citrus segments become relatively as important as citrus juices there would be a market for an additional 50 to 60 million boxes. Perhaps it is too optimistic to expect such a large place for citrus in the canned fruit market; but half this much, or 25 million boxes, seems

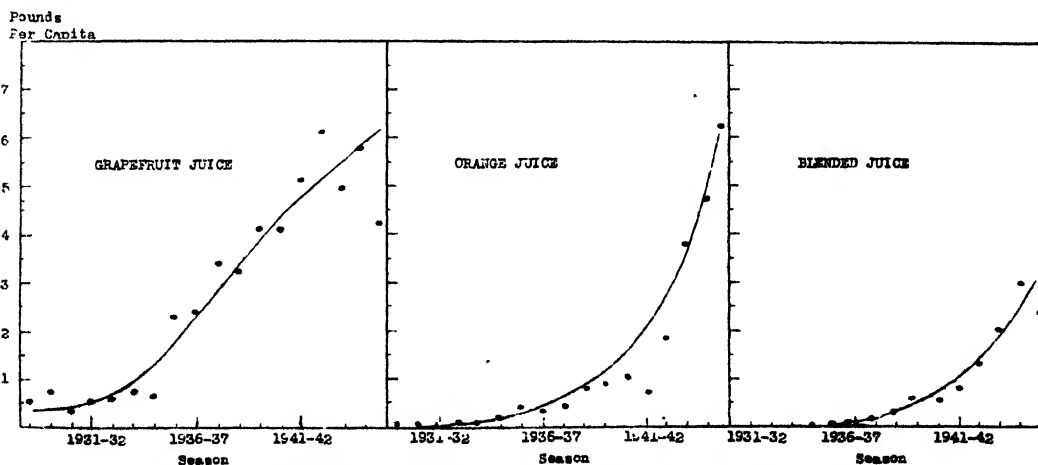


Fig. 1. United States per capita pack of citrus juices 1929 to 1946

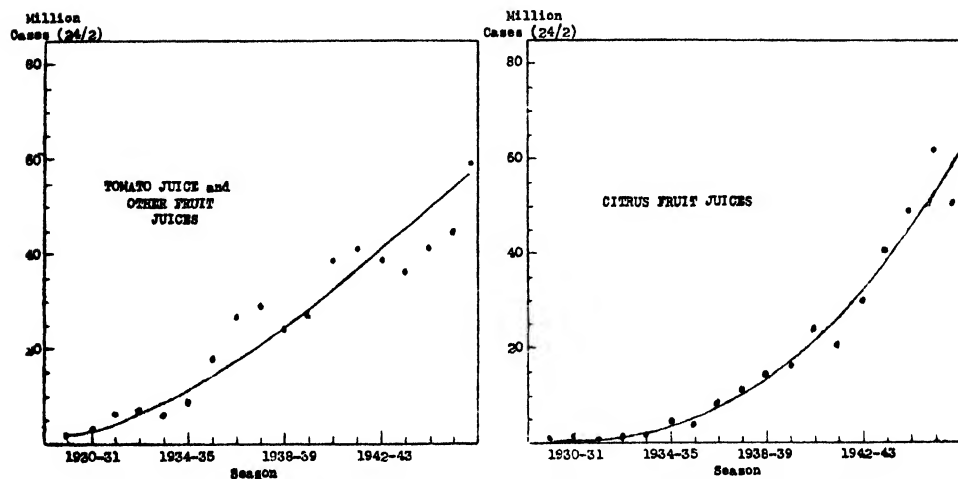


Fig. 2 United States pack of citrus juices, tomato juice, and other fruit juices

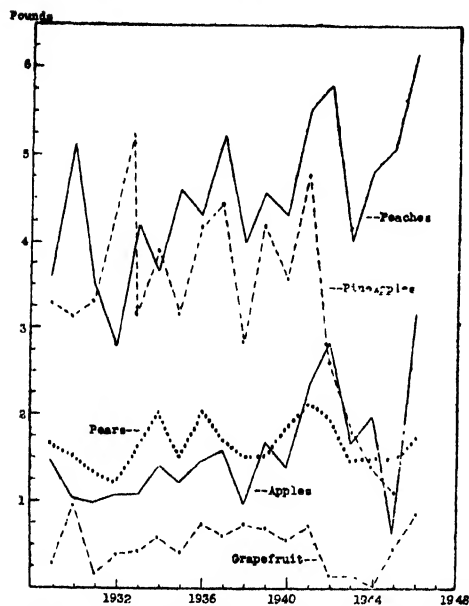


Fig. 3. Per capita pack of fruits 1929 to 1946.

a conservative goal. High cost of processing segment fruit is an adverse factor in obtaining greater production at the moment.

The trend in production and consumption concerns us because of the bearing on price.

The price of Florida oranges in the past has been determined largely by the supply of United States oranges, the disposable incomes of consumers, and competing commodities. From 1937 to 1946 a change in the United States supply of oranges by one-million boxes was associated with a reverse change in price of approximately 2 1/2 cents per box. From 1937 to 1946 a change of disposable incomes of individuals of one-billion dollars was associated with a corresponding change in price of approximately 3 1/2 cents per box. Low prices last year are believed to have been due to the reappearance of competing commodities and the carry over of processed products.

Dr. Wellman, of California, showed several years ago that when adjustments were made for disposable income, a given supply of oranges would sell for a higher price per box with the passing of time. This he attributed, and rightly so, to the upward trend of demand. His data show a decided flattening out of the demand pattern since the year 1930. That is to say, the rate of increase in demand, when adjusted for disposable incomes, is slowing down. In fact, it may be that in the case of winter oranges the rate of increase in demand for fresh

oranges has ceased to be a factor and that the saturation point has been reached.

Close observers in Florida are aware that for the past 10 or 12 years there has been no increase in the Florida shipments of fresh grapefruit. The indications are that the demand for fresh grapefruit, when adjusted for changes in disposable incomes, has about reached the saturation point.

Should disposable income be reduced greatly, without question the price of oranges will fall at the rate of about 3 1/2 cents per box for each billion dollars fall in disposable income. The fall in grapefruit price will be at the rate of about 2 cents per box for each billion dollars decrease in income. Because the trend of increased demand with passing of time for fresh oranges and grapefruit has flattened out, we cannot expect an increase in price fresh fruit with passing of time when disposable incomes and supply remain constant, as in the past. However, because the juice market has not reached the saturation point it is believed that the increased rate of demand for citrus juices and canned segments might go far over a period of the next few years in relieving the effects of increased supplies.

#### INTERRELATION OF SUPPLY AND PRICE

Price analyses usually show the effect of supply on price. Too often the effect of price on future supply is not studied. Forecasts of future supply have been attempted on the basis of acreage of bearing grove, length of life of tree, young groves already planted or the rate of planting of groves; or, arriving at the rate of increase in bearing surface of groves and projecting this into the future. It is well that we have such analyses, and far be it from me to belittle them. However, in our opinion a more realistic approach would be to try and analyze the effect of price on supply.

There is a fairly positive correlation between price and planting of oranges in Florida and a good correlation between price and planting of Florida grapefruit. A more

significant relationship is that of price and production the following year. Your at-

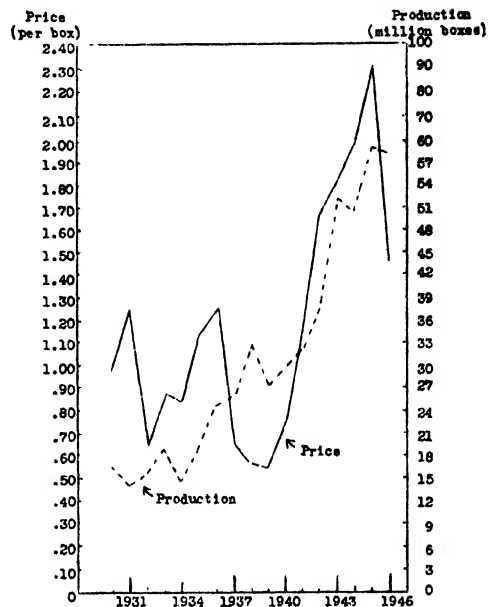


Fig. 4. Relation of Florida orange on tree price to the production the following year, 1932-1946. (Production based on Crop Estimating Board's first estimate.)

attention is directed to the effect of price on production from 1932 to 1936, a period of rising orange prices, when the price of Florida oranges increased from about 65 cents per box to about \$1.30 per box. Florida production of oranges increased from 15 million boxes in 1933 to about 26 million boxes in 1937, or about 70 percent. From 1936 to 1939, a period of falling prices, the price of Florida oranges decreased from \$1.30 per box to about 55 cents per box, production increased from 26 million boxes in 1937 to 31 million boxes in 1940, or only 20 percent. From 1939 to 1945, a period of rising prices, the price increased from 55 cents per box to \$2.35 per box and production increased from 31 million boxes in 1940 to 58 million boxes in 1945 (including loss from freeze), or almost 100 percent.



(Figure 4). On the average, orange production increased at the rate of 14 percent per year during a period of rising prices and only 5 percent during a period of falling prices

The picture is more striking with grapefruit. From 1935 to 1940, a period of falling grapefruit prices, the price of Florida grapefruit decreased from about 75 cents per box to about 35 cents per box. The production from 1935 to 1941 increased from about 15 million boxes to about 20 million boxes, or only 25 percent. From 1940 to 1944, a period of rising grapefruit prices, the price increased from 35 cents per box to about \$1.55 per box, but the production increased from 20 million boxes in 1941 to 33 million boxes in 1945, or 65 percent (Figure 5). On the average, grapefruit production increased 13 percent per year during the period of rising prices, but only 3 1/2 percent per year during the period of falling prices. Both in the case of oranges and grapefruit production has increased about three or four times as fast during a period of rising prices as during a period of falling prices. Such relationship between price and supply can only be accounted

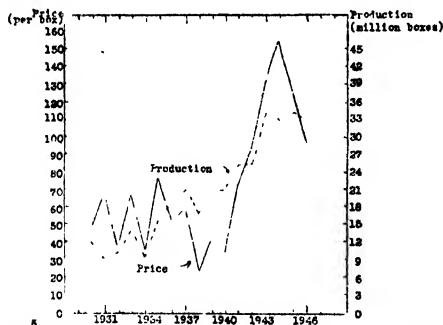


Figure 5. Relation of Florida grapefruit on tree price to the production the following year, 1930 - 1946. (Production based on C.F.R. 1st estimate report.)

for by increased fertilization, water, and generally improved care of groves. It is interesting to note that in California such relationship does not exist, presumably because in California the difference in the cost of supplying enough water to keep

a grove alive and the optimum amount for production is very small. Because water is the most costly factor in the production of California oranges and because it must be applied to keep the grove alive, growers must also use liberal amounts of fertilizer, sprays and culture in order to keep their factors of production in balance.

If this reasoning is correct, should prices fall the production of oranges in California would be affected but little. On the other hand, notwithstanding the large planting in recent years, the increased production Florida oranges certainly would not be expected to continue at the present high rate of recent years. Actually, there may be but little increase in production, depending on how low prices go.

A further factor which will tend to keep California production up is the high per-acre investment in California groves, relative to the value of the current crop as compared to the low investment in Florida groves as compared to the value of the current crop.

In addition, the California industry, at the moment, does not have the large acreage of young groves that must be taken care of. Almost every acre of California groves is in full production, or near full production; but in Florida there is a large acreage of young groves which will not take care of itself. Therefore, in the last ditch fight if it should come within the next two to five years, every acre of California grove is a fighting acre, but in Florida a great acreage is young and not able to take care of itself, to say nothing of contributing to the fight. It should not be inferred that this temporary situation, with respect to young groves, is permanent. In the end, the area will stay in production which has the lowest cost from the bloom to the consumer, providing the demand is the same.

Because a considerable amount of the young groves are in strong financial hands, the situation is not as bad as it would be otherwise. Also because of the complete integration of the marketing and production

operations in Florida, the Florida citrus industry has strength. It is also to the advantage of the Florida industry that many grove owners have other businesses. And finally because marketing firms and care-taking organizations render the services of production it makes it possible, if necessary, for grove owners to spend long periods of time away from their groves in order to engage in other activities.

#### MARKETING

The layman more often attributes low prices to poor marketing than to anything else. We sometimes hear that no better job of marketing is done today than was done 30 years ago. Such is not in accordance with the facts, but I shall not labor the point for our job is to appraise the marketing situation, not to show the progress that has been made in marketing.

Marketing consists of those services involved in getting citrus fruit from the tree to the consumer. Therefore, such things as distribution as to place and time, selling, packing, processing citrus products, advertising, price flexibilities, grades and standards, transportation, market uses, storage, and many other things are involved. Time will not permit a detailed analysis of all phases of marketing, however, attention can be given to some of the more important phases.

*Distribution.* In the case of oranges the general pattern of distribution has not changed greatly in the past 20 years. New York, New Jersey, Massachusetts, Connecticut and Pennsylvania get by far the largest quantity of Florida oranges and grapefruit. On the bases of government statistics it appears that New York alone gets about as many Florida oranges as all the southern states east of the Mississippi. On first thought this seems to be poor distribution, but on a careful analysis it is good distribution. The population of New York is about 2/3 the population of the southern states, but the per capita income is about twice as great. Actually the purchasing power of

New York is as great as all the southern states east of the Mississippi River. According to the United States Census, retail food sales in New York State are considerably greater than in all the southern states other than Texas. In 1944 New York State purchased more "E" bonds than all southern states east of the Mississippi River. If I were selling oranges, I would choose an area where the sale of "E" bonds was high. This is what has been done for many years so far as Florida oranges are concerned.

In the case of grapefruit the pattern of distribution has changed considerably in the past 20 years. The eastern markets receive a much greater proportion of Florida grapefruit today than in the period 1925 to 1930. Obviously, the reason is the pressure of Texas fruit in the mid-western markets. In the 1934-35 season Florida had 4,399 cars on the New York auction and Texas had 27 cars. On the Chicago market Florida sold at auction 644 cars and Texas 386 cars. In 1946-47 Florida had 4,894 cars of grapefruit to sell at auction in New York City, and Texas had only 199 cars. On the Chicago auction market Florida sold only 154 cars, but Texas sold 980 cars. Similar situations have taken place on the Detroit, Cleveland, Cincinnati and St. Louis auction markets. Florida has been pretty much run out of the mid-west auction markets by Texas grapefruit. This change in the distribution pattern of grapefruit is not a result of poor marketing but of poor production. Remember it avails the Florida grower nothing to contend that Florida grapefruit is as good as Texas grapefruit. The thing that counts is what the consumer thinks about the two grapefruit. The consumer spends his own money not the Florida growers' money, and in the western markets he seems to prefer Texas grapefruit at Texas prices to Florida grapefruit at Florida prices.

Let us look at the time distribution, that is the week to week or day to day movement of Florida oranges and grapefruit. An examination of government statistics reveals

that the week to week movement of oranges in the case of California and Florida, and of grapefruit in the case of Texas and Florida as very much the same.

Regardless of how good the place or time distribution is as compared to Texas or California, one would be foolhardy to assume that there is no room for improvement. The problem of better distribution is both one of better merchandising by individual firms and of coordinating the efforts of all firms.

*Quality.* So much has been said about the improvement of quality (both external and internal) and maturity standards that it seems superfluous to mention it again; but what I have to say is with respect to fruit which is good when it leaves groves but becomes poor in quality before it reaches consumers. We need better preservation of fruit, either through treatment, wrappers, or refrigeration; however, I hope that we shall never preserve fresh fruit so well that the trade will not be in a hurry to dispose of it before it gets old. I would hate to think of citrus fruit ever reaching the point of table salt that sits on the retailer's shelf and waits to be purchased without any effort on the part of the retailer to sell it. What is needed is a system of merchandising that will keep fresh fruit moving to the retailer each day in quantities no greater than can be moved each day when good merchandising has been carried out.

*Price Flexibilities.* Most students of marketing feel that there is something wrong with the system of marketing in which prices are rather rigid at the retail level but very flexible at the grower level. That is to say that lower prices to producers often are not reflected in lower prices to consumers. This, in the opinion of many, is one of our major problems. What can be done about it? We would all like to know. It will require some careful research to solve this problem.

*Cost.* Not only high cost of marketing at the retail level and the wholesale level

concerns us, but particularly the high cost of harvesting, packing and selling at Florida points. In 1944-45 cost data on 70 packing houses reveal that 10 percent of the firms had costs of packing citrus fruit which averaged 18 percent lower than the average for the 70, and that 10 percent of the firms had costs which averaged 28 percent higher than the 70. Such wide variations means that the opportunity for lowering costs is good. Because costs of labor and materials are likely to remain high, the best avenue open for lowering cost is through increased efficiency.

*Transportation.* Freight rates have already advanced and are almost certain to advance more. Wages cannot go up without increasing freight rates. A 25 cents per box advance in freight rates costs the grower 25 cents per box. Don't be misled into believing that any increase in freight rate will be passed on to the consumer. The producer pays any increase in freight rates.

*Coordinating Marketing Organizations.* There is much that individual firms can do to correct some of our marketing practices. They can lower cost of packing or canning, improvement in quality and handling can be accomplished, and perhaps an improvement of price. But there are a number of things that could better be done if the marketing agencies were better coordinated. This was realized in 1894 when the Florida Fruit and Vegetable Growers' Association was organized, again in 1909 when the cooperative movement was greatly re-energized, again in 1928 when the Florida Citrus Growers' Clearinghouse Association was organized, and again in 1930 when the Farm Board made an effort to organize the industry. A better coordination of our marketing machinery should result in a system of feeding fruit to individual buyers on a basis that would enable them to have adequate supplies rather than burdensome supplies at times, which grow old before being consumed; it might offer some resistance to price flexibilities at the grower level, or make possible more flexibilities at the retail

level; it should enable a better coordination of sales with advertising; it should lower the cost of selling materially; it perhaps could, if need arose, establish export pools or market use pools; and last, but by no means least, it should enable a better educational process of what each individual unit needs to do to meet the over-all marketing problem.

#### GOVERNMENT PARTICIPATION

Government participation has been the rule in the Florida citrus industry. It has manifested itself in such things as maturity laws, compulsory grades, advertising, marketing agreements, market news services, relief purchases, stamp programs, and school lunch programs. It would be exceedingly difficult to get along without some Government participation. Government participation programs for the future are being proposed from day to day. They include support prices, floor prices, producer subsidies, producer allotments, shipper quotas, consumer subsidies, Government loans, stamp programs, two price systems, school lunch programs, parity prices, parity income, help for Europe, and many others.

Programs such as marketing quotas, producer allotments, support prices, floor prices, and loans, have a tendency to prevent needed shifts in the industry. They usually favor established concerns, whether grower or marketer, at the expense of new firms; they tend to keep the old way of doing things—after it is obsolete; they usually penalize new areas to the advantage of old areas.

Programs such as School Lunch, Stamp Plan or some modification of them, Better and More Food for the Masses, do not retard needed shifts. Programs which encourage better quality are particularly desirable. Restrictive and price programs tend to lose your markets to other areas,

or in some cases, to other commodities; whereas abundant or increased demand programs and quality programs tend to encourage consumers to turn to you for fruit rather than to some other area or other product.

#### WHAT ABOUT THE INDIVIDUAL GROWER?

Some growers are rightly concerned over the future. Too often we are inclined to think that we are helpless to do anything alone and that unless the industry is awakened to action all will be lost. The growers' individual problem is to do the job better than the other fellow. Since 1924 we have compiled data on prices received for fruit and cost of marketing fruit at the shipping point for various marketing firms. I want to give a few results from these studies as reported in Florida Agricultural Experiment Station Bulletin No. 386. From the 1925-26 season to the 1939-40 season, one firm, when weighted to reflect proper differential for types of fruit and varieties of fruit, received for the 15-year period approximately 21 percent higher f.o.b. prices than the average. During the same period a few firms each year had costs which were lower by 20 percent than the average. The Florida Agricultural Experiment Station has compiled the cost of producing citrus fruit by the acre and by the box for a large number of groves for about 20 years. If you will look over these data you will be amazed at the difference in cost among growers.

Between the average price received for fruit and the price received by the highest 10 percent there is enough profit to keep any grower in business. The difference in the average cost of producing fruit and the lowest 10 percent is sufficient to keep any grower in business. Growers affiliated with the firms in the lowest 10 percent of cost of packing should have no trouble of prospering in business.

# EXPERIMENTS ON PRODUCTION OF FEED YEAST FROM CITRUS PRESS JUICE<sup>1</sup>

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The Citrus Products Laboratory at Winter Haven, Florida, has been interested for several years in the production of feed yeast from the press juice obtained in the manufacture of dried pulp from citrus peel. In 1942 Nolte, von Loesecke and Pulley (1) published the results of their investigations in an article entitled "Feed Yeast and Industrial Alcohol from Citrus Press Juice." In their work a batch system was used which was somewhat slow in operation, but they did demonstrate that this raw material was suitable for the production of yeast and they obtained information on the composition of the press juice and yeast.

At the Southern Regional Research Laboratory of the Bureau of Agricultural and Industrial Chemistry, New Orleans, Louisiana, the Sweetpotato Products Division had encountered a similar situation on the utilization and disposal of some liquors obtained during the manufacture of starch from sweet potatoes. They had been investigating the possibilities of making yeast from these liquors and had developed a continuous method of conducting the fermentation (3). They had also constructed a pilot plant capable of handling up to 200 gallons per hour of waste liquor for demonstrating the process (4). It appeared that this method

showed excellent possibilities of adaptation to the manufacture of yeast from citrus press juice. A cooperative project was arranged with the Dr. P. Phillips Canning Company, Orlando, Florida, and the pilot plant was installed in a building adjacent to their cannery and feed mill. A similar laboratory experimental unit with propagator capacities of six gallons each was installed at the U. S. Citrus Products Station, Winter Haven, Florida.

In this discussion the term "feed yeast" is used, and some explanation of what is meant may be in order. The investigations were limited to the production of a grade of yeast suitable for feeding animals. The organism used was *Torula utilis*, one of the wild yeasts, which is fast growing and not as susceptible to contamination as the true yeasts. One might ask what particular value yeast would have in feeding. It is good for this purpose because of its high protein and vitamin contents. About half of the yeast is composed of high-quality protein, which is readily available to animals. The proteins in yeast are deficient in only one of the ten so-called essential amino acids, methionine. This deficiency can be corrected by addition to the diet of any of a number of cereals.

The yeast is high in the B vitamins, particularly B1 (thiamin) and B2 (riboflavin). Values of 1.4 to 2.7 mg. thiamin per 100 grams of yeast have been reported and a sample made in the current studies contained 2.9 mg. per 100 g. For riboflavin, values of 5.2 to 9.1 mg. per 100 g. of yeast have been reported and a sample made in the pilot plant contained 4.54 mg. per 100 g. The yeast is a good source of ergosterol which, upon irradiation, yields calciferol, one of the compounds showing vitamin D activity (D2). A sample of the yeast pro-

<sup>1</sup> Agricultural Chemical Research Division Contribution No. 222.

<sup>2</sup> Laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

duced in these experiments contained about one-half of one per cent of ergosterol. It is extracted commercially from yeast of particularly high content of this the compound. Significant quantities of niacin and pantothenic acid are also present.

The Medical Research Council of England in 1945 (2) published a review of some investigations on the use of yeast in the diet of humans and animals entitled "Food Yeast, A Survey of the Nutritive Value." The following is quoted from this publication.

"The results of the above experiments with animals show that the addition of food yeast greatly improves the nutritive value of a diet whose protein is otherwise derived mainly from cereals, the biological value of the mixture of the cereal proteins with those of yeast being equal to that of a similar mixture with those of milk. The good effects of the addition of food yeast to a white flour diet have demonstrated its value as a source of B vitamins."

In Germany during World War II several plants were erected for producing yeast from wood sugar and the yeast was used in preparing "ersatz" foods.

The press juice from the citrus feed mill offers many advantages for the production of feed yeast. The juice is rich in carbohydrates which can be utilized in the growth of yeast. It is available at centralized points in sufficient quantities to make large-scale production possible, and at sufficiently uniform rates to permit continuous operation. The manufacture of yeast would not require the expensive vacuum concentration necessary for the manufacture of molasses; it is ready for use as it is. When the liquor is used for the manufacture of yeast its biological oxygen demand (B.O.D) is greatly reduced, and this simplifies disposal of the resulting effluent.

Accurate records of the amounts of press juice obtained in the citrus feed mills are generally not maintained, but an approxima-

tion of the amount and the possible yield of yeast can be made. It is estimated that a 90-pound box of citrus fruit will yield about three gallons of press juice of approximately 10 per cent soluble solids. From these three gallons, about a pound of dried yeast can be produced. Potential total production might be as much as 25,000 tons per year.

During the war it was profitable to concentrate the citrus press juice into a molasses or sirup in multiple-effect vacuum evaporators. The product was used in the compounding of mixed feeds. With the return of more normal times competition with blackstrap molasses is to be expected and the additional uses for the press juice are desirable. The strength of the press juice makes it impossible to dispose of it in sewers, lakes or other bodies of water in most locations. It must be treated or processed in some manner.

In this discussion it will not be possible to describe the pilot plant in detail, but the general method of operation can be given.

The juice pressed from the ground, limed, citrus peel was pumped from the feed mill to the yeast pilot plant without any treatment. In the pilot plant it was first passed through an 80-mesh vibrating screen to remove particles of suspended matter that might later clog pipe lines, screens, or the nozzles of the yeast centrifuge. It is not to be expected that the small amount of suspended matter remaining in the juice will be later collected with the yeast by the high-speed yeast centrifuge, but it is not objectionable in the feed.

The juice was then pumped through a heater to a large storage tank and held at 140° F. to prevent premature fermentation and destruction of the sugars. This supply tank was necessary because the feed mill was shut down for a few hours during the night while the yeast pilot plant operated continuously. From the storage tank the juice was pumped through a pasteurizer where it was heated to 200° F. to destroy microorganisms, then through a cooler to

where it was cooled to approximately room temperature, and then directly into the yeast propagators. Concentrated nutrient solution was also pumped continuously to the propagator in a quantity proportioned to the feed rate of the press juice. The nutrient solution contained the phosphate and ammonium salts necessary for yeast growth.

Three yeast propagators, each capable of holding 500 gallons of liquid, were arranged in series so that the liquid flowed successively through them. Porous aeration tubes in the bottom of each propagator provided the continuous flow of air necessary for rapid yeast growth. The propagators were fitted with cooling coils for dissipation of the heat generated by the fermentation, and temperatures were maintained at about 96° F.

In the yeast propagators the yeast multiplied and utilized the carbohydrates and other nutrient materials. Since the plant operated continuously, a suspension of yeast discharged continuously from the system. This yeast suspension was pumped to a collecting tank and thence to a continuous centrifuge. This special type of centrifuge discharged the yeast as a thick slurry suitably concentrated for drying on a steam-heated double drum drier.

The large pilot plant was placed in operation as follows: The propagators and all connecting lines were sterilized with flowing steam, and 200 gallons of pasteurized press juice and the necessary nutrients were pumped into the first propagator. About 20 gallons of an actively growing culture were added. Aeration had been started as soon as the steam was turned off. In the course of six to eight hours, 200 gallons of an active culture were built up. Approximately 200 gallons more of pasteurized press juice and nutrients were then added, and about two hours allowed for the culture to build up before continuous flow of press juice was started and maintained. No new culture was added from this point on.

During operation determinations were

made of yeast counts, yeast volume, yeast weight, pH, phosphates, ammonia nitrogen, total organic matter, sugars utilized, and oxygen consumed. B.O.D. values of the effluent and observations on the amounts of liquid in each propagator and gas analyses of the air coming from the propagators were made.

The pilot plant was first placed in operation at Orlando in May and June, 1946. At the beginning trouble was encountered with foaming and it was evident that unless this difficulty were overcome, the method would not be practical. At times half the liquid and yeast were lost through the air vents in the tops of the propagators. An antifoam mixture was used which is still considered good, but even with large amounts of it, the foaming was not adequately controlled. During the latter part of this period a system of eight-inch pipes was installed at the tops of the propagators which conducted the foam from the first propagator to the second, the second to the third, and finally to the yeast collecting tank. The air vents used previously were closed. This modification was found to work very well and solved this problem. Not only was the foam kept within bounds, but it eliminated the necessity for any antifoam mixture during continuous operation. The propagators remained reasonably full of liquid. Since then, this system has proved itself over an extended period of operation.

Experimental work with the pilot plant at Orlando was resumed in March, 1947, and continued for a period of three weeks. The Dr. P. Phillips Canning Company then operated the pilot plant for a short time and produced additional quantities of yeast. The smaller experimental unit in Winter Haven was operated during April, May and June, 1947.

The results of all the experimental operations on feed yeast will be summarized briefly:

It was found that the continuous method of propagating yeast as developed by the Sweetpotato Products Division of the

Southern Regional Research Laboratory was adaptable to citrus press juice. Continuous operation, twenty-four hours a day, has been maintained without apparent decrease in the activity of the culture for periods as long as a month. The results indicate the propagation can be continued almost indefinitely without any new culture. Experience in operation on citrus waste liquor to date indicates that three stages of propagation may not be required to obtain satisfactory yields. One stage should be sufficient and certainly not more than two stages. With a single-stage system the air required and the cost of the plant will be less. The total detention time in single-stage plant would be only about three hours.

Ammonium sulfate and tri-sodium phosphate were found to be satisfactory as sources of nitrogen and phosphorus. Other compounds of ammonia and phosphate can doubtless be used as long as the proper ratios are maintained and the proper alkalinity furnished for pH control. It was found that the pH could be maintained in the proper range between 4 and 5 by the addition of the nutrient used.

The maximum feed rate for the large pilot plant was approximately 185 gallons per hour. This means that the liquid remained in each propagator less than three hours. Higher rates of feed resulted in the incomplete utilization of the sugars and low yields. Yields of 60% of yeast resulted when the press juice was diluted with two volumes of water. With full-strength press juice yields of 33% were obtained, based on the weight of sugar present. Perhaps with some modification the higher yields obtained by diluting the juice can be realized with full-strength press juice, but this has not been accomplished to date.

In describing the plant operation, it was mentioned that the press juice was pasteurized by heating to 200° F. This is considered advisable while a new culture is being developed in the propagator, but it was found that successful operation could be maintained without pasteurizing the press

juice fed to the plant after continuous operation had been established. The organism, "*Torula utilis*," appear to outgrow the few other organisms that may be present. Generally the citrus pulp is heated before it is pressed and this greatly reduces the number of initial micro-organisms. It is fortunate that pasteurization is not necessary because the press juice rapidly deposits a scale when heated in a heat exchanger and frequent cleaning is necessary.

Yeast was produced with as little as 500 cubic feet of air per pound of yeast. Experiments are not complete on this point and it may be possible to use less air than this. In the commercial manufacture of compressed yeast by the batch system, the amount of air used per pound of yeast produced generally exceeds 1200 cubic feet.

It was found that the peel oils present in the press juice did not interfere with the propagation of yeast. These volatile oils were reduced to negligible amounts by the air blown through the propagators.

During passage through the propagators approximately 95 per cent of the sugars were utilized, about 65 per cent of the total organic matter was destroyed, the reduction in the B.O.D. was about 80 per cent and the reduction of the oxygen consumed value was about 75 per cent. This is considered efficient operation because it is not to be expected that the yeast could utilize all the different types of organic compounds present.

The centrifuge which is commonly used with compressed yeast was found to be suitable for separating the *Torula utilis* as a thick slurry. The drum drier operated in a satisfactory manner in producing dried yeast. The product was fluffy, light in color and could easily be ground to a fine powder. It had a characteristic flavor and was slightly bitter, due to the small amount of the residual citrus press juice dried with the yeast.

Most of the information needed to design a commercial plant has been obtained. Ex-



perimental work on certain phases will be continued.

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## BACTERIOLOGICAL SURVEY OF SOME CITRUS CANNERIES IN FLORIDA WITH SPECIAL ATTENTION TO *ESCHERICHIA COLI*<sup>1</sup>

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*Escherichia coli* is an organism commonly associated with a certain type of bacterial contamination. The presence of *E. coli* should be given serious attention even though it is generally considered harmless because it is commonly found in the intestinal tract of warm-blooded animals. When this organism is present it is considered evidence of contamination, usually fecal, and indicates a health hazard. There is the danger that other bacteria capable of producing typhoid fever, dysentery, or other intestinal diseases may be present. The presence of *E. coli* in a food product may be determined by a series of simple tests. The American Public Health Association has recommended a standard routine check to determine the presence of *E. coli* in milk and water supplies and has been of great value in safeguarding the consumer's health. They have been a valuable aid in developing suitable sanitary measures so

essential to healthful living. The results of routine analyses supported by differential tests as applied to citrus cannery equipment and unpasteurized citrus fruit products are presented in this discussion.

Samplings were made at ten citrus canneries in the Winter Haven area over a period of three years. Each plant was inspected at least once and several of them three times a season. The investigation included samples of the unwashed fruit, washed fruit, and of material from washers, conveyors, sizers, juice extractors, juice troughs, and juice blending tanks.

A brief description of the steps taken while the search for *E. coli* in unpasteurized products will be given. A known dilution is made with sterile water from the thoroughly agitated liquid portion of a sample. Petri dishes of eosin-methylene blue (E.M.B.) agar are inoculated with some of the diluted sample; observations are made at the end of 18 and 24 hours of incubation at 37° C. Eosin-methylene blue agar is a selective medium. It is a mixture of lactose (milk sugar), other nutrients, and dyes. When *E. coli* grows on the surface of this medium, the dyes are incorporated with the cell growth, and a colony is formed that is distinctive in appearance for *E. coli*. The diagnosis of colonies grown on this medium requires a skill that may be devel-

<sup>1</sup> Agricultural Chemical Research Division Contribution No. 223.

<sup>2</sup> One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

oped through careful observations and comparisons with *E. coli* grown on the same medium.

Well isolated colonies are chosen for making bacterial suspensions in sterile water blanks from which lactose (milk sugar) broth and media for differential tests are inoculated. The differential test media and the purposes they serve are as follows: Fryptone solution, the first to be considered, is digested by *E. coli*, and indol is formed; the byproduct of growth is recognized as a color in solution when certain analytical reagents are added. Next in order is glucose

not formed. The test with Gram's stain was negative. Acid and gas were formed in lactose (positive reaction). Indol was produced. Methyl red reaction was positive in glucose and Voges-Proskauer test was negative. There was no growth on citric acid medium (negative reaction).

When these tests were applied to organisms in citrus fruit products, *E. coli* was not found among the lactose fermenting, gram-negative, nonspore-forming rods. A summary of results for "Imvic" tests made during the last three seasons showed organisms representing six groups (Table 1)

TABLE 1  
"IMVIC" TEST GROUPS OF EOSIN-METHYLENE BLUE AGAR SELECTED COLONIES

Group	Indol	Methyl Red	Voges-Proskauer	Citric Acid
1	-	-	+	+
2	-	+	-	+
3	+	+	+	+
4	-	-	-	+
5	+	+	-	+
6	-	+	+	-

solution which gives two differential characteristics, *E. coli* forms acid in glucose which is strong enough to cause methyl red indicator to turn red when added to the medium, the other characteristic sought for in this fermentation is the formation of acetoin. The Voges-Proskauer test is employed, and the reagents used cause a color formation in the medium when acetoin is present. The test is negative if *E. coli* has been grown in glucose. A medium containing citric acid as the only carbon nutrient present is the last in the series, and this medium will not support the growth of *E. coli*. These differential tests are known as the "Imvic" tests. Other differential media may be added to the list but these are considered the minimum number of tests to decide the absence of *E. coli* in a product.

A brief description of *E. coli* is gleaned from cultures on these media follows: The bacterium was a short rod. Spores were

Many of the colonies selected from eosin-methylene blue (E. M. B.) agar plates resembled *E. coli* so closely that one with little experience would be inclined to call them coli positive. The experienced worker might be inclined to call them negative, yet would feel that it was very unwise not to proceed with differential tests. It was observed that these organisms formed colonies on E. M. B. agar much more slowly than *E. coli*; incubations usually required 48 and sometimes 72 hours.

These E. M. B. selected organisms and *E. coli* are very easily destroyed by heat, therefore, a product that has been pasteurized would not show visible forms. *E. coli* inoculated into orange juice (acidity 0.7 per cent) at room temperature was not viable after four days. As the concentration of solids increased, the death rate of *E. coli* increased. At 31 per cent dry substance, as determined by the refractometer,

viable *E. coli* was not found after 48 hours. The behavior of the unidentified E. M. B. selected bacteria almost paralleled that of *E. coli*. Grapefruit sections inoculated with *E. coli* and unidentified E. M. B. selected organisms were frozen and stored at sub-zero temperatures. *E. coli* was not found after eight days, but some of the other kinds were found after two months. The effect on viability of high-solid concentrations and citrus juice in sub-zero storage has not been investigated.

It would be interesting to know about the origin and distribution of these organisms that resemble *E. coli* so closely in appearance when grown in lactose broth and on eosin-methylene blue agar. Such knowledge might be a means of preventing economic loss to the producer when a hasty inspection would otherwise lead to the condemnation of his product and his plant sanitary program. Some thought has been given to this phase of the work, but a complete story cannot be given at this time. Many of those bacteria are known to live in soil normally, and one would expect that they enter the plant with the fruit. The surface of washed fruit has been checked for this type of contamination, but the tests were negative. The conveyor system was seldom found to be contaminated with these organisms, but the

extractors and the juice collected at the extractors carried these bacteria almost invariably. Fruit flies (*Drosophila*) pass these organisms alive from their bodies, and it is possible that they contribute considerable contamination to the extractors when they are feeding on micro-plant life (yeasts and bacteria) and juice. Where the fruit flies collect the contamination distributed by them has not been determined. It is also possible that fruit which seems to be normal in outward appearance has sub-surface defects due to injuries and that the bacteria in question may come from such fruit which has begun to spoil.

This paper is a brief report on eosin-methylene blue (E. M. B.) agar selected bacteria collected from ten citrus fruit processing plants in the Winter Haven area. The investigation extended over three seasons. Each plant was investigated at least once, and some of them three times during the season. *Fischerichia coli* was not found in the unpasteurized fruit product examined. The significance of the E. M. B. agar selected bacteria resembling *E. coli* has not been established. Additional work should be done to determine the source and significance of these bacteria in citrus fruit processing plant.

# STORAGE STUDIES ON FROZEN CITRUS CONCENTRATES\*

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The wide acceptance of orange juice concentrate, a new frozen food made by low temperature evaporation, (1), suggested the advisability of publishing observations on its storage characteristics. Briefly, the concentrate is made from fresh orange juice by boiling off water at about 55°F. in vacuum concentrators. The concentrate, having 50 percent by weight of solids, is diluted to 42 percent by addition of fresh juice. The material is then chilled to 15 to 20° F., filled into cans, frozen, and held at 0° to -10° F. The consumer partially thaws the material and reconstitutes by mixing three volumes of water with one of concentrate. Further details of the process have recently been reviewed by Burton (2). The concentrate should not be confused with the conventional product made in typical vacuum pans at a temperature of 100° F. or higher.

As pointed out previously (2, 4) use of fresh juice to provide better flavor and aroma in frozen concentrates was developed by MacDowell, Moore, and Atkins of the Florida Citrus Commission, working at the U. S. Citrus Products Station in Winter Haven, Florida. A comprehensive review

of the literature and commercial practice in this field up to 1945 is given by Moore, Atkins, Wiederhold, MacDowell, and Heid (7).

The stability of citrus juice concentrates made at low temperatures is of special importance. The data to be presented indicate that the taste and ascorbic acid content retained closely approximate fresh raw juice rather than canned pasteurized single-strength juice. To maintain this quality, the product is kept in storage at approximately 0°F. However, consumers may hold the product at higher temperatures for varying periods of time. The present report, therefore, gives data for storage at several temperature levels. The effect of several processing variations is also discussed.

## PROCEDURE

Batches of concentrate were made in a pilot plant evaporator at approximately 55°F. and packaged in tin cans with and without added fresh single-strength juice. For certain experiments, described more fully below, some of the concentrate was pasteurized. Unless otherwise indicated, the plain tin cans of five ounce capacity were sealed under 27 inches of vacuum and stored at 0° F. in a small walk-in cold room. Constant temperature boxes were constructed for other storage temperatures. Occasionally, commercially prepared concentrate was studied. This was made also by low temperature evaporation (2). This product requires a far shorter processing time than that used in the pilot plant, and the taste was definitely far superior to the concentrate made in the pilot plant. Storage studies were scheduled for six months or one year.

\* This is an abstract of a paper presented in June, 1947, at the Boston meeting of the Institute of Food Technologists.

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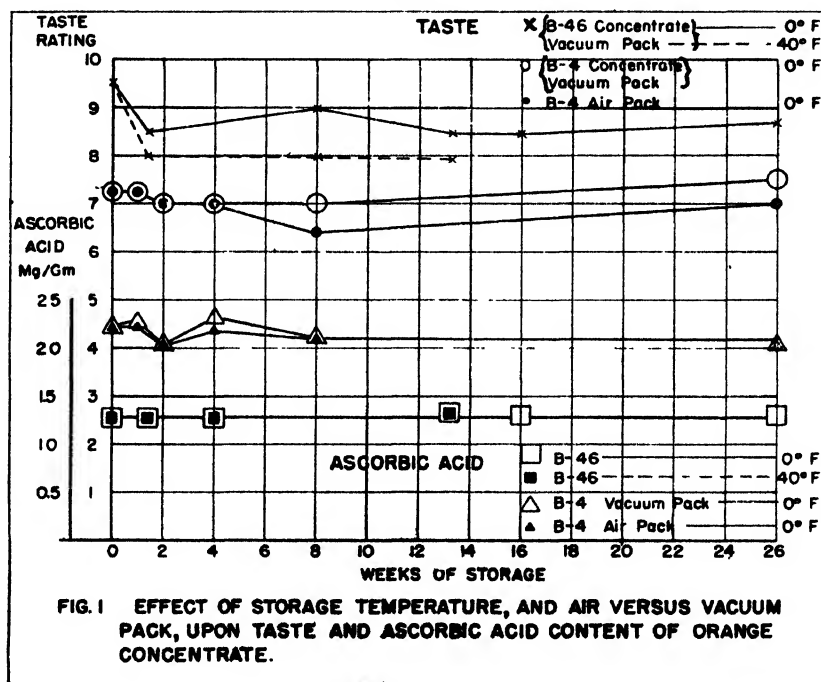
<sup>2</sup> Vacuum Foods Corporation, Plymouth, Florida.

<sup>3</sup> Citrus Research Laboratory at Plymouth, Florida.

Taste ratings were made on all samples using a range from 1 to 10, where 10 represents an excellent raw freshly-extracted juice; 8, a reconstituted juice of good quality; 7, a juice of fair quality when compared to raw fresh juice; 6, a minimum level of acceptability for a commercial concentrate; 4, a poor product; and 0 to 2, a

case of pasteurized products or products stored for long periods at high temperatures, several different off-tastes appeared; thus, one taster sensitive to a very slight fermented odor would show a marked preference for a pasteurized product while those sensitive to a "processed" taste reacted in just the opposite direction. In general, the members,

Fig. 1



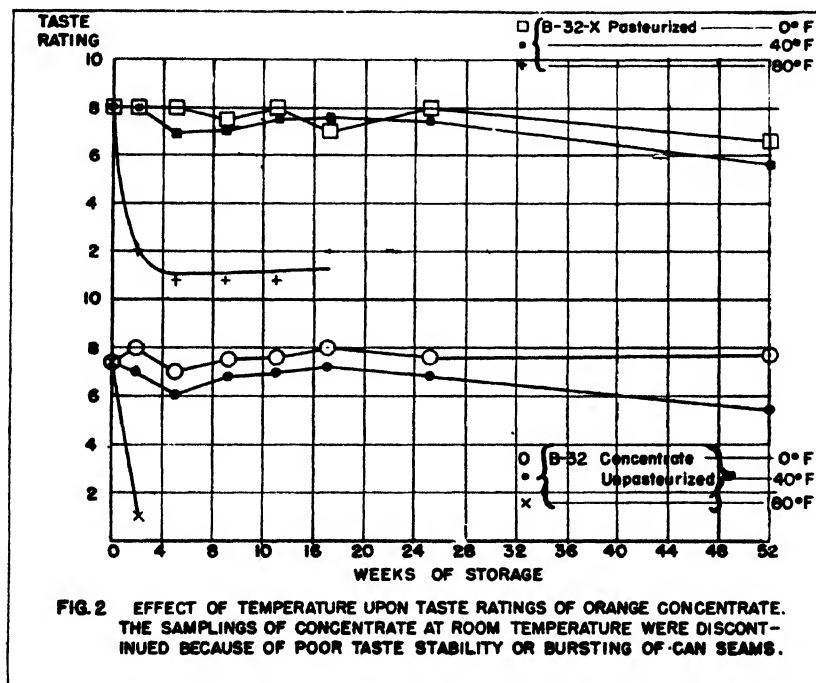
foul tasting one. All samples were evaluated for aroma, but since the values were almost identical to taste ratings, they are not given. Three or more people independently evaluated the samples for taste and aroma; the values were averaged for use in the tables and graphs. Where sharp differences among tasters arose, however, the separate evaluations were retained. In the

of the taste panel checked each other within one-half taste unit. For any given experiment, the samples were tasted side by side, in coded beakers so that the tasters did not know what the samples were, and the emphasis was upon *differences* between samples. As to the absolute magnitude of the taste ratings, this varied because of lack of taste memory. In a laboratory where

for months several storage experiments on orange concentrate and orange powder from different batches of oranges were started each week, one found it hard to be sure whether a given sample should be called 8 or 7.5. Differences between samples were easy to detect, however, which served the purpose of the experiments. The tasters

with periodic checks by the modifications of Robinson and Stotz (10) and Rubin, Jahns, and Bauernfeind (11) for reductions, dehydroascorbic acid, and metal interferences. Daily standardizations were made with crystalline ascorbic acid. Negligible amounts of dehydroascorbic acid were found and thus, unless otherwise noted,

Fig. 2



were periodically checked for their reproducibility. Only men who could accurately reproduce their evaluations were retained on the panel.

Citric acid and pH were determined; the latter data showed no notable changes and are not included except where differences were observed. Ascorbic acid was determined by the method of Bessey and King(1)

data in this report represent reduced ascorbic acid.

#### RESULTS

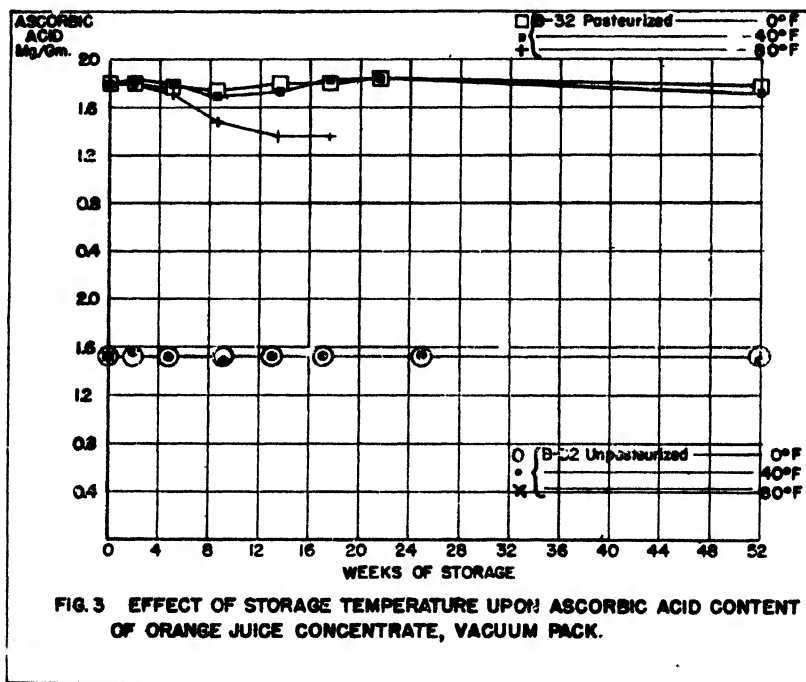
Temperature of storage is indeed important for an unpasteurized product such as a frozen food. Figure 1 gives a comparison between storage temperatures of 0° and 40° F. The taste ratings were generally 0.5 to 1.0 taste rating lower for concentrate held

at 40° F. than for concentrate held at 0° F. The differences in taste were more marked for a commercial product containing added fresh juice such as used in experiment B-46, which had an initial taste rating of 9.5, than they were in experiment B-18, Table 1, where a pilot plant concentrate made of early season juice was used.

nental Can Company for the analyses in the columns headed by the initials C. C. C. and an asterisk. Their taste data represent averages of six people in a taste panel. Usually, as was the case also in experiment B-46, the taste ratings dropped progressively in going from 0° to 20° to 40° to 75°.

Ascorbic acid analyses, presented in

Fig. 3



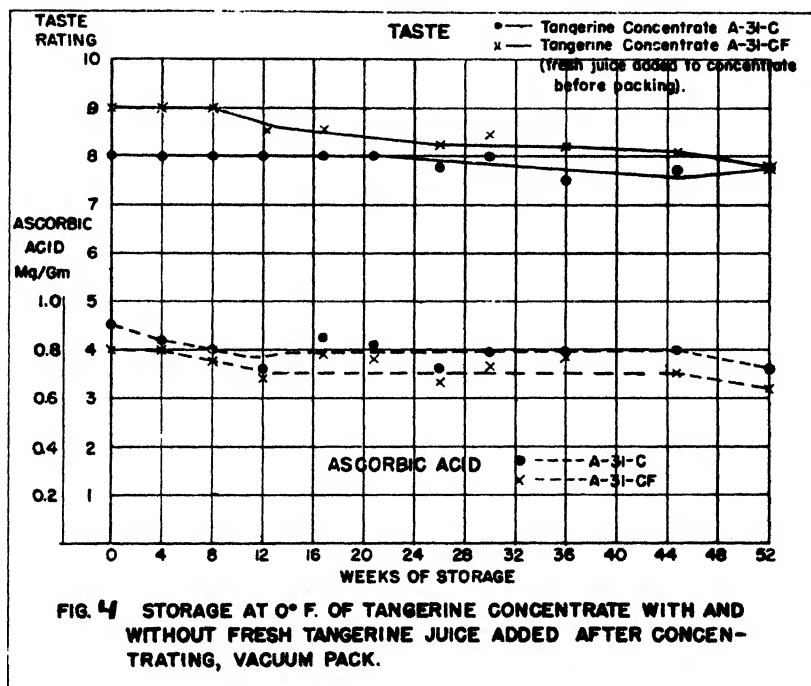
In experiment B-18, Table 1, fresh juice was not added back to the concentrate after concentration or before canning. Table 1 gives data for taste, ascorbic and citric acids for experiment B-18 which was packed cooperatively in Plymouth by this laboratory and John Boyd and Gordon Chissom of the Continental Can Company. We are indebted to W. J. Mutschler of the Conti-

Table 1 and Figure 1, indicate no loss, within experimental limits, in samples B-46 at 0° for six months. The B-46 (Figure 1) sample was stored only four months at 40° F. at which time no loss in ascorbic acid was observed. In experiment B-32, Figure 3, orange concentrate stored one year is seen to lose very little ascorbic acid. The initial figure was 1.53 milligrams per gram

of concentrate while after one year at 0°, B-32 had 1.50 mg/g as determined by the Bessey and King technic. A test for reduction (10)—materials other than ascorbic acid which reduce the indophenol dye used in titration—was negative while interferences caused by tin or iron (10) were found to be equivalent to 0.03 mg of ascorbic acid

ten or fifteen per cent higher than we report. Both laboratories used indophenol titration. An additional experiment, B-24, was stored at 0°, 10°, 20°, 30°, and 40°F. and is not presented in detail because of lack of space. After one year, the losses ranged from one per cent at 0° F. to three per cent at 40° F. Moore *et al* (8) have reported

Fig. 4



per gram. Thus, the drop for one year was from 1.53 to 1.47, or less than four per cent of the total amount present. The values for B-32 at 40° were comparable as were those for B-32-X, pasteurized, at both temperatures. Somewhat greater differences were found in one experiment, B-18. It will be observed that the data for ascorbic acid analyses reported by Mutschler (9) were

that commercially packed single-strength orange juice in tin cans shows an ascorbic acid loss of about 5% when stored at 40° F. for six months. However, they report an 18% loss when the juice is stored six months at 80° F., the standard commercial storage temperature.

Figure 2 shows changes in taste as a function of time and temperature of storage. The

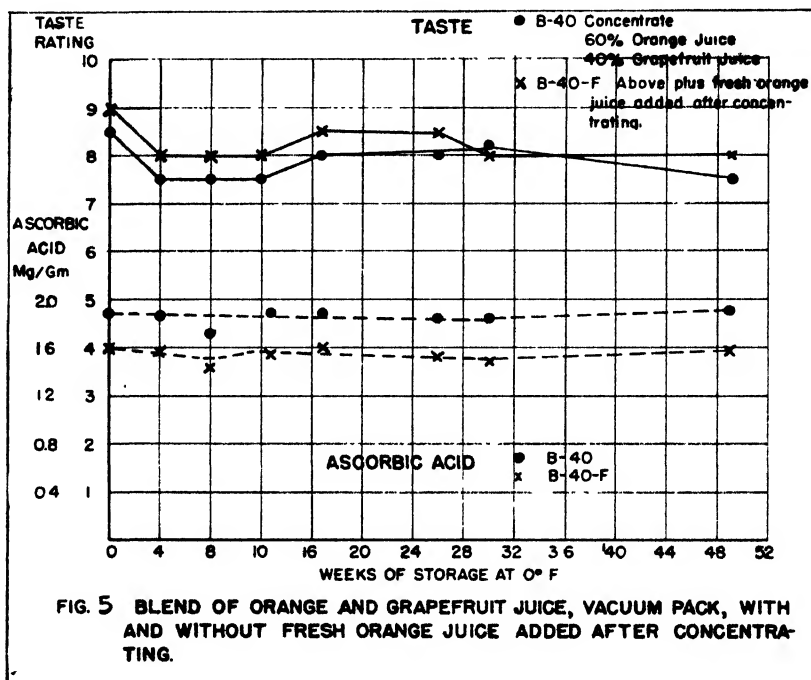


taste, ratings were most stable at 0°F., slightly less at 40°F., while at 80°F. the concentrate was soon unpalatable. After one year the pasteurized product had a rating of about one taste unit lower than the unpasteurized product.

Figures 4 and 5 show ascorbic acid retentions in concentrates made from tange-

the advantage of addition of fresh juice back to concentrate. In this case, concentrates were made having 50 per cent solids and fresh juice was added to bring the solids to 42 per cent. The taste was improved by one taste unit for tangerine juice and 0.5 units for the grapefruit-orange blend. The difference between the tastes

Fig. 5



rine juice and from a blend of orange and grapefruit juice. The stability of ascorbic acid in tangerine juice is evidently less than that in orange juice or in a mixture of orange juice and grapefruit juice. Not shown for lack of space are data on lime juice concentrate which were similar to those found for tangerine concentrate.

Figures 4 and 5 graphically demonstrate

tends to be less as storage proceeds, suggesting that the volatiles restored by addition of fresh juice are somewhat less stable than the other less volatile flavor constituents.

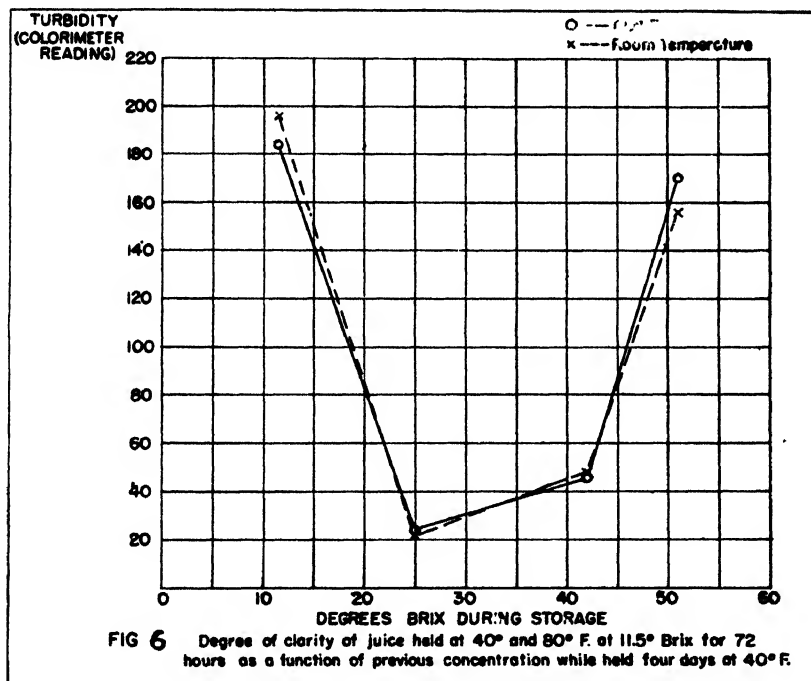
Table 1, Experiment B-18, shows variations in citric acid during storage. The experiment compares (B-18-A) hot-filled concentrate pasteurized 3.3 seconds at 85°F.

with cold-filled unpasteurized concentrates, (B-18-D) nitrogen-packed, (B-18-E) vacuum packed, and (B-18-F) air-packed. During storage, there is a trend toward higher acid values in alphabetical order of the treatments, (A) through (F). No regular variation was observed with changes in temperature, but in all samples there was

in citric acid in the remaining experiments were small and are not shown for lack of space.

Clarification of citrus juices is an important commercial factor. One often observes that freshly extracted orange juice becomes unsightly in appearance after standing several hours at room temperature. Gross

Fig. 6



a slight decrease in acidity. Since the standard sodium hydroxide was periodically standardized with potassium acid phthalate and found to be stable, the slight differences which occur were felt to be true differences. It was felt that possibly the greater amount of oxygen in the air-packed samples might be associated with oxidation of some organic compound to a titratable acid. Changes

particles of pulp settle out and the colloidal yellow "cloud" becomes a clear light yellow serum. Joslyn and Sedky (5) have reviewed the problem and showed that the enzyme associated with clarification can be partially inhibited or almost completely inactivated by heating to 80°C. for several minutes. In this laboratory, juice pasteurized several seconds at or above 205°F., the common

TABLE 1.  
STORAGE OF ORANGE JUICE CONCENTRATE  
Weeks in Storage, Experiment B—17

Sample	No.	Initial C.C.C.*	2.5 Weeks		4 Weeks		4 Weeks C.C.C.*		8 Weeks		16 Weeks		16 Wks C.C.*	
			0°	20°	40°	0°	20°	40°	0°	20°	0°	20°	0°	40°
Taste Rating	A	7+	5.5	7.5	7.5	7	6.5	6.5	5.7	5.7	7	8	6.4	6.3
	D	7+	7.7	6.5	—	7.5	—	7	7.8	—	—	7.5	7.9	—
	E	7+	8.1	7.0	7.5	7	7	6.5	5.7	7.9	7.5	7	7.9	7.8
	F	7+	7.6	7.5	7.5	7	7	7	7.4	7.7	7.5	7.5	8.0	7.4
Ascorbic Acid mg/g	A	2.14	1.78	1.75	1.78	1.86	1.84	1.82	—	—	1.76	1.83	1.74	—
	D	2.14	1.78	—	1.81	1.82	—	1.81	—	—	1.68	—	1.75	—
	E	2.14	1.88	1.77	1.78	1.83	1.99	1.83	—	—	1.80	1.92	1.79	—
	F	2.14	1.92	1.72	1.83	1.80	1.86	1.90	—	—	1.77	1.87	1.80	—
Percent Citric Acid	A	4.21	3.78	3.85	3.81	3.86	3.89	3.82	—	—	3.83	3.79	4.00	—
	D	4.21	3.79	—	3.88	3.94	—	3.94	—	—	3.74	—	4.05	—
	E	4.21	4.09	3.95	3.79	4.00	4.27	3.90	—	—	3.98	4.16	4.27	—
	F	4.21	4.10	3.71	3.86	3.85	3.95	4.09	—	—	3.97	4.06	4.27	—

\*Data from Continental Can Company.

\*Sample A was concentrate heated 3.3 seconds at 185° F., filled hot in 5 ounce cans and dropped into ice water two minutes after filling.

Samples D, E and F were not pasteurized and were filled cold.

Sample D was placed in a vacuum chamber brought to 28.5 inches of vacuum Nitrogen was introduced and the cans were sealed at approximately atmospheric pressure.

Sample E was vacuum packed at 28.5 inches vacuum.

Sample F was sealed with air in the headspace of the can

TABLE 1—Continued

Sample	No.	26 Weeks		26 Weeks C.C.C.*		38 Weeks		52 Weeks		52 Weeks C.C.C.*	
		0°	40°	0°	40°	0°	75°	0°	0°	0°	75°
Taste Rating	A	7.5	7.5	7.5	6.1	6.6	2.8	7	7	7	6.8
	D	8	—	7+	—	—	—	8	8+	—	—
	E	8	7.5	7	7.4	7.7	—	8	8+	8.0	7.4
	F	8	7.5+	7	7.5	6.7	—	8-	7	7.6	6.9
Ascorbic Acid mg/g	A	1.70	1.76	1.75	1.75	1.73	—	1.73	1.70	2.01	2.06
	D	1.75	—	1.76	1.76	1.71	—	1.71	1.70	—	—
	E	1.82	1.84	1.79	1.79	1.78	—	1.78	1.81	2.02	2.15
	F	1.85	1.81	1.86	1.86	1.82	—	1.82	1.78	2.09	2.03
Percent Citric Acid	A	3.84	3.88	3.79	3.79	3.67	—	3.67	3.68	—	—
	D	3.94	—	3.95	3.95	3.78	—	3.78	3.69	—	—
	E	4.10	4.16	3.89	3.89	3.90	—	3.90	3.96	—	—
	F	4.14	3.95	4.13	4.13	4.00	—	4.00	3.88	—	—

\*Data from Continental Can Company

practice in Florida with concentrate for export, showed no tendency to clarify. Thus, pasteurized juice clarifies slowly or not at all.

It would be expected that the concentrates described here would be subject to extremely rapid clarification. Qualitatively, we have observed fresh juice to clear in much shorter time than the concentrates made from it. Specifically, samples of fresh Valencia orange juice and the concentrate made from it were brought up to 86°F. and stored at room temperature with added sodium benzoate. The concentrate was taken from the can line just before being sealed. It was reconstituted to the original fresh juice concentration. After six hours, the fresh juice had a line separating a turbid cloud above from a dark orange, more opaque base below. The reconstituted juice showed no separation. After 22 hours, the fresh juice had settled further and the "cloud" above had noticeably cleared while the reconstituted concentrate still gave no evidence of clearing.

Clarification rates in orange juice after reconstitution to 11.5° Brix, were studied as a function of concentration of orange juice solids during storage at 40°F. An orange concentrate, 15 months old, was removed from the 0°F. cold room. It was stored at various concentrations for four days at 40°F. The concentrations studied were 51° Brix, its original strength, and 42, 25, and 11.5° Brix made up with sterile water and placed in sterile tubes at (a) 40°F. and (b) 80°F., room temperature. After three days, the turbidities were read in a colorimeter as per Loeffler (6). The higher the reading the more turbid was the juice. Figure 6 shows that clarification was most rapid in the samples stored at 25° Brix, next most at 42° Brix. Unexpected was the fact that previous storage at 11.5 and 51° Brix at 40°F. was associated with very slight clarification. This was observed for the same concentrations in a previous experiment with fresh concentrate. Cruess et al (3) reported that

adding sugar to lemon juice retarded clarification. In both experiments, cans were stored both full and one-half full. In the latter, there was a tend toward very slightly lower rates of clarification. Figure 6 indicates, finally, that the rates of clarification of the reconstituted juice were almost identical at 40°F. and room temperature. Although the above was carried out on two different samples of concentrate with identical results, it would be of interest to repeat clarification tests in another season on several varieties of oranges.

A series of seven samples representing commercial operation during 1947 up to mid-April were tested for rate of clarification of reconstituted juice, Table 3. These samples represented concentrate made from various early-, mid-, and late-season juices which had been stored at 0° to -10°F. up until the time of testing. A total of seven samples of frozen concentrate were removed from the cold room and thawed as rapidly as possible in warm water. A portion of each of the seven samples was then reconstituted and kept at refrigerator temperature (51°F.) in test tubes for observation over a 24-hour period. The unreconstituted remainder of each thawed concentrate sample was kept in the refrigerator (51°F.). At the end of 24 hours, 48 hours, and 72 hours, portions of each sample of thawed concentrate were reconstituted and observed.

All samples tested held up for 24 hours after reconstitution when such reconstitution was done immediately after thawing. When reconstituted after having thawed 24, 48, and 72 hours at 51°F., behavior of the reconstituted product became progressively worse. The sample made up after 72 hours of thawing separated almost immediately upon reconstitution and was the only sample observed that gave a completely clear upper liquid level.

In short, 0°F. (or lower) was the best storage temperature for concentrate to protect flavor and physical stability after reconstitution.

Vacuum-packed concentrate was compared to air-packed in experiment B-4, Figure 1, and experiment B-17, Table I. After 8 weeks at 0°F., the orange concentrate packed under vacuum was superior to the air-packed product, Figure 1. The differences were not consistent until after 26 weeks in experiment B-18. Thus, at 38 and 52 weeks, concentrates packed in nitrogen or under vacuum were superior in taste to those sealed with air in the headspace. The magnitude of the differences among the various packing methods was approximately one-half taste unit for these two batches of concentrate, neither of which had fresh juice added back. In view of the behavior of tangerine juice, where after a year, the advantage of added fresh juice was lost, a short experiment with commercial concentrate containing added fresh juice was carried out. A uniform batch of concentrate was (a) air-packed, (b) packed under 27 inches vacuum, and (c) packed with nitrogen after evacuating to approximately 29 inches of vacuum. The initial taste rating was 9.5. After one month at 0°F., the taste ratings were 9, 9.5, and 9 in the above order while after five months, they were 8+, 9, and 8.5+, respectively. Perhaps the nitrogen pack suffered from loss of volatiles owing to the higher vacuum employed. There was some frothing in the cans during evacuation. The advantage of the vacuum pack, however, was decisive.

#### CONCLUSIONS

Commercially prepared frozen orange juice concentrate exhibits excellent retention of aroma, taste, and ascorbic and citric acids during storage at 0°F. Concentrates stored at temperatures as high as 40°F. retain ascorbic acid almost as well as at 0°F., but flavor is degraded somewhat. Negligible amounts of dehydro-ascorbic acid are present in orange concentrate stored for long periods of time. Storage at 40°F. is a distinct disadvantage if the reconstituted

juice is not to be consumed immediately since enzyme action results in clarification and separation of the colloidal constituents producing an unsightly appearance. The low-temperature fast-cycle concentrating process reduces enzyme action slightly. Samples of orange concentrate stored a year at 0°F. have a stable "cloud" when reconstituted.

Air had a detrimental effect upon the storage stability of orange concentrate. Flavor retention is better in vacuum-packed cans than in air-packed cans.

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## REPORT ON CITRUS BEVERAGE BASE RESEARCH

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### SUMMARY

This report reviews studies by Research Fellows of the Florida Citrus Commission on the production of bases for blended citrus juice beverages. Orange, grapefruit, and lime concentrates were investigated in preparing a variety of "ade" bases designed to yield a beverage containing a minimum of 30 percent of juice. The sugar, acid and essential oil components are reviewed; emulsifying and dispersing agents are discussed.

### INTRODUCTION

The consumption of non-alcoholic bottled beverages in this country has created a multi-million dollar industry. Estimates furnished by the American Bottlers of Carbonated Beverages, Washington, D. C. (1) indicates a retail consumption increasing from \$760,000 in 1849 to \$589,849.56 in 1946. In 1849 36,000,000 bottles of non-alcoholic beverages were consumed by the American public. In 1946 this figure reached the staggering total of 17,695,000,000. The per capita consumption of bottled soft drinks has grown from 1.6 in 1849 to 125.3 in 1946.

In recent years beverages containing

fruit juice have contributed to this volume. The use of fruit juices and concentrates in beverages was reported by Cruess and Irish in 1923 (2), and by Irish in 1925 (3). Cruess and Aref (4), and Bailey (5) reported on the composition of fruit juice beverages during the period 1933-1936. These beverage flavors included apple, lemon, grapefruit, orange, grape, pineapple, cherry, loganberry, strawberry, and raspberry. However, of the fruit juice beverages that have been introduced, only citrus juice beverages, orange, lemon, lime and grapefruit became widely popular. Bailey (5) in reporting the composition of orange products, noted that the juice content (as estimated from the ash analysis) averaged 15 percent. Later analysis by Bailey (6) (7) indicate juice contents for orangeade beverages of 12-20 percent (1939) and 14-32 percent (1940).

On June 4, 1947, the Florida Citrus Commission authorized research on citrus beverage bases, stipulating that initial studies should be toward the formulation of a citrus "ade" of (1) high juice content and (2) a character distinctive to Florida. It was also considered desirable to incorporate a maximum amount of grapefruit juice to assist in extending the market for this fruit.

Facilities for the project were furnished in cooperation with the University of Florida at the Citrus Experiment Station, Lake Alfred.

### MATERIALS

The concentrated orange juice used in

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these tests was supplied by a commercial plant, and had been prepared by conventional methods of low pressure evaporation, described in the literature (8).

The grapefruit concentrate was prepared from Duncan variety fruit in May, 1947. The juice was extracted in Rotary juice presses, strained through a 00 screen, and held in storage without pasteurization. The unpasteurized juice was continuously fed to a circulating evaporator where it was heated to 105 degrees F and allowed to expand in a vacuum of approximately 29.6". The juice was recycled a sufficient number of times to raise the soluble solids content to 56 percent. The concentrate was then passed through a Mallory sterilizer, attaining a temperature of 240° F. for one second. The heated concentrate was transferred to a vacuum expansion chamber and flash cooled to 160° F. The cooled concentrate was then filled into 96 oz. (No. 10) containers, sealed under vacuum, cooled to room temperature in a conventional cooler, dried, and placed in cases. The cased product was then transferred to cold storage (450° F. or lower.) (9)

The lime concentrate was supplied in unpasteurized, frozen form. This product was prepared by a commercial process described in the literature (10). One pound of sucrose was added per gallon of raw lime juice, prior to concentration.

The analysis of the concentrates on the date of receipt by the project

	Grape- Orange fruit Lime		
Percent soluble solids	64.23	61.42	51.52
Percent titratable acid			
(as citric) . . . . .	4.50	4.69	24.30

Soluble solids were determined by the method of Stevens and Baier (11). Titratable acidity were determined by Official Methods of the Association of Official Agricultural Chemists (12).

Essential oils were furnished to the project by several processors. The oils utilized by the project:

- Oil of orange, cold pressed, Floridian
- Oil of tangerine, vacuum steam distilled, Floridian
- Oil of lemon, cold pressed, Californian
- Oil of grapefruit, vacuum steam distilled, Floridian
- Oil of grapefruit, cold pressed, Floridian
- Oil of lime, distilled and concentrated to five-fold, source unknown.

The above oils were submitted to J. W. Kesterson, Associate Chemist, University of Florida, Citrus Experiment Station, Lake Alfred, for analysis and concentrating. Representative samples of each oil (excepting lime were concentrated by Kesterson for the project.

#### EXPERIMENTAL

A preliminary stock base was first developed, from which variations in essential oils, emulsifying agents, preservatives, etc., could be studied.

The amount of concentrate used in making the base was predicated on a final beverage containing 30 percent soluble juice solids, and employing approximately equal volumes of orange and grapefruit concentrates. Additional sucrose and citric acid were necessary to satisfy the total soluble solids and ratio requirements of the beverage.

The formula for one gallon of this beverage base without the addition of flavoring oils:

- 34 fl. oz. concentrated grapefruit juice.
- 34 fl. oz. concentrated orange juice.
- 1.73 lbs. sucrose.
- 0.31 lb. citric acid.
- 29 fl. oz. water.

This base, when diluted with an equal volume of 32° Beaume (59.1° Brix) sucrose syrup, and further diluted (or "thrown") with 5 volumes of water, yielded a beverage of the following calculated composition:



Degrees Brix.....	11.9
Percent titratable acid (citric)....	0.48
Percent citrus juice....	30.0

Initial studies with essential oils were based on a maximum oil content of 0.03 percent in the finished beverage. It was soon found on dilution that this amount was entirely too great, and it was reduced until a taste level satisfactory to the authors was attained. This level was finally found to be 0.0026 percent.

After establishing this taste level, attention was paid to the character of the flavor attained by varying the essential oils. It was soon noted that an orange-flavored drink could be made from the above stock base, by using only orange oil, but there was nothing distinctive to the product, since the objective of the work was to make a beverage with a *unique* flavor representative of Florida citrus. Combinations of oils were then tried. Combinations of orange oil with grapefruit oil did not prove satisfactory, grapefruit oil adding nothing to the flavor, and the oil mixture deteriorating rapidly.

The next oil combination tried was orange and tangerine. This mixture showed promise in lending an unusual flavor to the product. However, all tasters could detect the grapefruit concentrate character in the product, and did not care for that part of the flavor. Lemon oil was blended with the orange and tangerine oils, but the lemon oil masked the orange fraction of the flavor.

The final, successful, combination was a blend of orange, tangerine, and lime oils. After proper adjustment of the ratio between the three oils, a desirable flavor type was obtained.

The lime oil seemed to mask the grapefruit character of the drink, and in combination with the orange and tangerine oils, contributed a unique flavor. Project personnel and others commented that the flavor was distinctively citrus in character, but no one of the three flavor components could be selected as outstanding. This combination seemed to have the most promise in

accomplishing the objective insofar as flavor was concerned.

After establishment of the ratio of orange, tangerine, and lime oils to produce the flavor type most acceptable to a taste panel, studies were undertaken to determine the advantages—if any—of employing concentrated oils. Three, five, and ten fold concentrations of the orange oil were prepared; three and five fold concentrations of the tangerine. The five fold oils were selected as superior to the others. Comparison by taste panel of beverages prepared from single strength and five fold oils indicated a preference for the concentrated oils. Insufficient data have been collected on the storage stability above 44° F. of bases prepared from single strength and concentrated oils to report at this time. It has been demonstrated, however, that minimum flavor change has occurred in storage at 40° F. or less, over the 4 month period the project has been underway.

The blend of concentrated oils finally selected as most desirable was composed of

38 parts five-fold orange oil, Floridian.

19 parts five-fold tangerine oil, Floridian.

1 part five-fold lime oil.

1.2 ml. oils, blended as above were employed per gallon of beverage base.

In all of the experiments with oils the tasters commented that the drinks lacked "fruity" character. The type of flavor noted above seemed to be the most desirable, but it was not "rich" or "fruity" enough. Commercial beverage base often includes the use of salt to develop flavor, and this use has been noted by Jacobs (18). Salt has also been used in soft drink beverages to increase the sweetness of sugar solutions, as noted by Jacobs (14) and Dunn (15). Sodium chloride was therefore incorporated in the beverage base in an amount equivalent to 0.15 percent in the finished beverage. A decided improvement in flavor was noted. This was checked several times during the course of

the studies, by comparison of beverages. All tasters selected the beverage containing salt as superior in flavor to the one without.

Further improvement in the beverage was attained by the incorporation of frozen concentrated lime juice. An amount of lime concentrate sufficient to satisfy 57 percent of the added citric acid requirement was incorporated into the base. This amount of lime concn rate definitely improved the "fruity" character of the flavor of the beverage. Shelf-life studies over a two week period at room temperature (80-90° F.) indicated no flavor change or loss of "cloud." This beverage was given preference over all others by a taste panel.

Flavor enhancement was also noted in a series of studies made with surface active agents employed to disperse the oils. The orange-tangerine-lime mixture was dispersed with the aid of *lauryl pyridinium chloride*. This material was furnished to the project in the form of a solution containing 30 percent active L.P.C. thirty-six ml of the oil mixture were blended with 10ml of lauryl pyridinium chloride and 250 g dextrose. The blend of oils, dispersing agent and sugar was placed in a Waring Blendor and the mixer turned on. Sufficient distilled water was rapidly added to effect incorporation of the ingredients. Distilled water was further added to the suspension to give a final volume of 800 ml. This suspension was used to dose a quantity of beverage base in an amount sufficient to furnish the required concentration of oils. The amount of surface active agent (on an active ingredient basis) in the ultimate finished beverage was 0.00019 percent.

Beverages were submitted to a taste panel, representing (1) the basic oil mixture emulsified with gum acacia and (2) dispersed with lauryl pyridinium chloride. Two beverages were prepared for each agent; one containing salt, and one with salt withheld. The tasters selected the beverage containing lauryl pyridinium chloride and salt as the one with the most desirable flavor, commenting that the flavor was more "fruity." How-

ever, all tasters noted an "astringent" after taste.

Similar studies were performed with another surface active agent, alkyl dimethylbenzylammonium chloride. This product had a flavor of its own which could be detected in all dilutions employed in the experiment. Further studies with surface active agents as dispersing agents for citrus oils have been deferred. These products have not been approved for use in foods by the Food and Drug Administration.

During the period of examining essential oil blends for suitability, many studies were made with regard to the efficacy of various emulsifying agents. Pectin was originally employed, in the forms of dry powder and a stock solution. An aqueous mixture containing 3 percent 100 grade citrus pectin proved to be satisfactory in producing an emulsion containing 15 percent of essential oils. The resultant emulsion—and all others containing pectin or gums—was homogenized by passage through an Eppenbach QV 6 colloid mill, utilizing minimum operating clearance between rotor and stator. A less satisfactory emulsion was prepared by dispersing dry pectin in the oils, before adding the aqueous phase. The stability of such emulsions was not uniform, and the thorough emulsification of the oils was dependent on the operator's ability to add the aqueous phase at a correct rate.

Gum acacia proved to be an efficient emulsifier. Here again, stable emulsions were consistently prepared when a stock aqueous solution of the gum was employed. Following recommended procedure for a "cloudy" type orange emulsion (16), 16 ounces of gum acacia were dissolved in 16 ounces of water, the solution filtered, and used to emulsify 0.75 ounces of blended oils. An emulsion volume sufficient to satisfy the oil requirements of the beverage was added to the base, substituting this amount for part of the water component of the formula. No significant increase in the "cloud" of the finished beverage was noted by the authors.

As a result of techniques employed in the handling of surface agents as dispersants for oils, a method of utilizing gums in the dry state was developed which resulted in consistently stable emulsions. An amount of dextrose sufficient to absorb the essential oils and prevent a "dry" mix was employed. After determining the amount of gum required, the gum and dextrose were "folded" together, and the essential oils blended in. This "dry" mix is then transferred to a high speed mixer (such as a Waring Blender), and while mixing, the aqueous phase is added in an amount sufficient to produce an emulsion of the consistency of milk. The resultant emulsion was then diluted to any required volume and homogenized. This technique has proved very successful in insuring complete emulsification of the oils.

Gum tragacanth proved to be superior to gum acacia as an emulsifier. Less tragacanth need be employed to obtain a stable emulsion. The usual amount employed in these studies was 5g, of tragacanth, 20ml oils, 50g dextrose, and water to make an emulsion volume of approximately 500 ml. When employing gum acacia, the amount was increased to 8-10 g.

Studies were undertaken to determine the effect of preservatives in varying concentrations. Sodium benzoate was incorporated into the base in an amount sufficient to give a concentration of 0.05 per cent in finished beverage. This concentration of preservative was detected by a majority of tasters. Lesser concentrations of preservatives were tried, but spotty spoilage developed in these concentrations. Therefore we do not recommend a concentration of preservative in the finished beverage of less than .05 per cent.

It is possible to market this product as a pasteurized beverage. Quite a number of bottling plants are now equipped to handle beverages in this form. If the product is intended for this particular purpose, no preservative need be included if storage of the beverage base at 40°F. or lower is strictly adhered to.

## CONCLUSION

Summarizing the work reported above the following formula for one gallon beverage base incorporates the results of all the studies made thus far:

34 oz. orange concentrate  
34 oz. grapefruit concentrate  
11.0 oz. lime concentrate  
784 grams sucrose  
68 grams citric acid  
32 grams sodium chloride  
1.2 ml oil (in emulsion)  
29 oz. water

Use: 1 gallon beverage base

1 gallon 32 Beaume sucrose syrup

Throw: 1 oz. to 6 oz. bottle

*Note:* The oils are blended in the ratio noted on page 6. Fifty ml of blended oils are mixed with 150g dextrose and 5g gum tragacanth and emulsified by the technique noted above. After the emulsion volume has been established and the emulsion homogenized, the amount of emulsion required to furnish 1.2 ml. blended oils per gallon of base can be determined.

The beverage has the unique flavor characteristic originally set as one of the goals for this project. It also uses a high proportion of grapefruit, another objective of the project. Finally, it opens for Florida citrus an outlet which should have worthwhile possibilities from an economic standpoint.

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## INTERNAL FRUIT QUALITY AS RELATED TO PRODUCTION PRACTICES

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It has been suggested that a practical paper covering the relationship between internal fruit quality and production practices would be appropriate at this time. An attempt has been made to keep the discussion simple and at the same time present in a general way what are considered good technical contributions by various research workers in the field. To try to discuss all of the factors which are reported by fact and fiction to influence citrus "maturity" and fruit quality would be a hopeless task in the time allotted. This represents only a humble attempt to try and correlate some of what we know, plus a few logical assumptions, with some of the practical con-

cepts about citrus "maturity" and fruit quality.

It is to be regretted that our present maturity standards do not serve as a better criterion of taste and flavor of citrus juice. It has long been recognized that the ratio serves little more than a satisfactory index of sweetness and sourness. Work by Cowart (2) of the Citrus Experiment Station, shows that at any given degree of sweetness, total solids is the best criterion of flavor. A juice with low solids is weak and flat and lacking in character while high solids gives juice character and richness or "body." The results of this work indicate that both artificially adjusted juice and natural orange juice having less than 8.8 percent solids is not acceptable to taste and has very little flavor regardless of the variety or acid content. Oranges with sol-

uble solids as low as 8.8 percent were of common occurrence in Florida before the present fertilizer and spray programs using supplemental elements became widely accepted. The results of this work showed in general that with acceptable acidity, juice was considered fairly good with solids ranging from 8.8 to 10.0 percent, and good when the solids went above the ten percent level. The finest quality of juice was obtained where solids ranged about 13.00 percent accompanied by proper acid balance. The last figure is essentially representative of the midseason and late oranges now being generally produced within the State. Through the years it has become apparent that a careful analysis of fruit juices to determine their acid, sugar, soluble solids, vitamin C, juice content, etc. serves as a reasonably accurate index of fruit quality and further that such analysis can be used as a definite means of evaluating quality of fruits produced under varying conditions. The problem of determining the conditions which may affect changes in fruit quality becomes complex. There is a great deal of information about some of these conditions but in other cases data is insufficient or lacking entirely.

#### WEATHER AFFECTS FRUIT QUALITY

Many citrus growers have long recognized that weather conditions affect to a considerable extent the quality of the fruit which can be produced in any particular season. Fewer realize that weather conditions can cause differences in fruit quality as great or greater than can be induced by any culture or nutritional treatment which has thus far been used in citrus culture in Florida. Judging from the records at the Citrus Station during the past seven years, we have had two high solids years during this period. These were the 1940-41 and 1942-43 seasons. The fruit produced during the 1940-41 season was somewhat better than the latter, and was the only season during the past seven years when seedy grapefruit on rough lemon root-stock

reached 10.00 percent total soluble solids by the latter part of September and approached 12.50 by the time it had reached prime quality condition. During the period from 1940 to 1944 there were two low and two high solids years. It would appear that differences caused by weather conditions which affect fruit quality should show up during this four year period. Oddly enough, no one element of weather is sufficiently outstanding from the study made thus far to enable one to say that it was the cause of the changes which have been noted. It would appear that these changes must be caused by a combination of weather factors rather than any one element of weather in particular. The high solids years, during the months of June, July, August and September are characterized by lower rainfall, a higher percentage of possible sunlight and a lower number of cloudy days. One of the high solids years (1940-41) had an early bloom; (approximately two to three weeks) the other did not. A check of the total available heat, according to the method suggested by Webber (14) failed to show any significant differences for the period in question. It is difficult to pick out elements of weather which affect fruit quality but the importance of these elements cannot be over-emphasized for much of the troubles we have been having with low solids Hamlin and Parson Brown oranges during the past few seasons is undoubtedly due to weather conditions. Increased knowledge of weather and how it affects physiological processes in citrus trees may in time permit predictions of some accuracy regarding the quality of fruit which may be expected under particular weather conditions.

There are a number of other factors affecting fruit quality concerning which information is more specific, and over which the grower can exercise much more control. The effect of root-stock has been investigated by Harding, Winston and Fisher (6) and by Harding and Fisher (7) and others. Only sour orange and rough lemon are commonly used as understocks in Florida at

the present time to any extent. Under similar conditions, sour orange stock can be expected to produce fruit of better quality than rough lemon but the latter may mature fruit slightly earlier (5). The effect of arsenic on "maturity" and fruit quality is, of course, very important for grapefruit. This problem is at the present time being investigated further by Mr. Reitz at the Citrus Station and will be reported on at later date.

#### FERTILIZATION AS RELATED TO FRUIT QUALITY

Largely because of the critical situation which developed during the early thirties with regard to deficiencies, investigations undertaken to determine their effects on growth production and fruit quality have been reported by a number of workers. Much has been done toward clarifying our knowledge of the effect of deficiencies of magnesium, manganese, zinc, and copper. The effect of these elements on the internal quality of citrus fruits has been reported by Cowart (3), Cowart and Stearns (4), Fudge and Fehmerling (5), Roy and Bahrt, (9), Skinner, Bahrt and Hughes (11), Sites (10), and Stearns and Sites (12). The results of these experiments have shown consistently the improvement in fruit quality which results from the correction of deficiencies of magnesium, manganese, zinc and copper. A deficiency of magnesium results in very marked decreases in soluble solids, acidity and vitamin C content, and it has been thoroughly demonstrated by plots at the Citrus Station that it is not possible to produce high quality fruit, maintain tree vigor or secure optimum production where a deficiency of magnesium exists. In view of the nature of some of the inquiries which have been received at the Citrus Station it is perhaps well to point out again certain facts with regard to the use of supplemental elements in the production of citrus so far as fruit quality is concerned.

A citrus tree by nature of its genetic con-

stitution, its root-stock and its soil and climate environment has certain limitations in the quality of fruit which it can produce regardless of the nutritional and cultural treatment which it may receive. Once deficiencies of the supplemental elements are corrected and the grove is on a good maintenance program there is no reason to believe that application of these elements other than are needed for maintenance will improve internal fruit quality. There is no information to show that any benefits are derived from luxury consumption of these elements by citrus. Certainly there is no evidence from any of the nutritional plots at the Citrus Station that higher solids fruit can be produced from additional nutritional sprays or by increasing the percentage of these elements in the fertilizer mixture over and above those which are recommended for the maintenance of tree vigor. This is mentioned because of repeated inquiries as to the desirability of applying additional applications of magnesium, and the advisability of applying additional nutritional sprays in an effort to raise the solids of grapefruit and early orange varieties.

While discussing the effect of supplemental elements on fruit quality, particularly grapefruit, it is perhaps well to repeat that there is no indication that the use of these elements tends to delay or to hasten to any extent the time at which the fruit will meet the State maturity requirements. This was reported on earlier by Cowart (3) and by Sites (10) and the results of recent years analyses tend to verify these reports.

#### SOURCE OF NITROGEN AS RELATED TO FRUIT QUALITY

Questions regarding the source of nitrogen are brought up frequently in connection with any consideration of citrus nutrition and fruit quality. There has been in operation at the Citrus Station since 1944 a nitrogen source experiment in which five different sources of nitrogen; nitrate of soda ( $\text{NaNO}_3$ ), ammonium sulfate ( $\text{NH}_4\text{SO}_4$ ), organic (castor pomace), urea (Ura-

mon) and ammonium nitrate ( $\text{NH}_4\text{NO}_3$ ) and combinations of these have been applied to Hamlin oranges. Except for one plot, a basic 4-6-8 4 1 1/2 analysis is applied to the entire block with the source of the nitrogen for the various plots changed in the mixture for each treatment. The trees receive three applications per year at the rate of ten pounds per tree per application. Plots in this block are sampled continuously from September through December. To date no differences of any significance have been found to exist in the internal quality of the fruit produced from any of the treatments. These results are in keeping with those reported by Camp (1) for grapefruit except that as yet no marked differences in external quality are apparent. It is certainly safe to assume based on the results of this experiment thus far that it is not reasonable to expect any quick changes to occur in fruit quality as a result of changes in the source of nitrogen in the fertilizer as long

as the ratio and the quantity is kept the same. Although inorganic nitrogen as the only source of nitrogen produces acceptable quality fruit so long as all the recognized needed elements are supplied there is no indication that all inorganic nitrogen is superior to the mixture of inorganic and organic now commonly used. In view of the unsatisfactory past history with regard to the use of all inorganic nitrogen in the fertilizer it would seem wise to at least continue to use mixtures containing at least as much organic nitrogen as is necessary to properly condition the fertilizer. Another point in favor of the use of some organic nitrogen is that it provides some safety against the development of deficiencies which are at present not recognized but which it is reasonable to believe might develop from a completely inorganic program. Nitrate of soda shows a slight advantage over the other forms of inorganic nitrogen which were used.

TABLE 1

FERTILIZER TREATMENT FOR POTASH EXPERIMENTAL PLOTS — BLOCK A \*

Series A						
Plot No	N%	P <sub>2</sub> O %	K <sub>2</sub> O%	MgO%	MnO%	CuO%
1 & 3	3	6	3	0	1	1/2
2 & 4	3	6	10	0	1	1/2
5	3	6	5	0	1	1/2
6	3	6	0	0	1	1/2

Series B						
Plot No	N%	P <sub>2</sub> O %	K <sub>2</sub> O%	MgO%	MnO%	CuO%
1 & 3	3	6	3	3	1	1/2
2 & 4	3	6	10	3	1	1/2
5	3	6	5	3	1	1/2
6	3	6	0	3	1	1/2

\* Plots receive 3 applications per year of the above mixtures at the rate of 15 pounds per tree per application. All plots receive a dormant nutritional zinc spray, 3 pounds  $\text{ZnSO}_4$  per 100 gallons.

POTASH FERTILIZATION IN RELATION  
TO FRUIT QUALITY

The recommendations of the Citrus Station with regard to the use of potash were reviewed by Camp (1) in 1944. At that time responses from the variable potash applications to Block V at the Citrus Station were beginning to be observed in the quality of fruit produced but they had not been continued sufficiently long to make adequate interpretation of the results. The fertilizer treatments applied to this block are summarized in Table I. The potassium treatments are split into two series, A and B. Series A is identical with B except that no magnesium is supplied to any of the plots in this series. Symptoms of potassium deficiency have been more pronounced during the past few years, especially in the series B plot. In view of the fact that potassium in any form has been withheld from the zero potassium plot since 1939, it is interesting to note that potassium deficiency symptoms in these trees have only in the past two or three years developed into more advanced stages. No consistent leaf chlorosis pattern has as yet been observed. The fruit from the deficiency plots is approximately two sizes smaller than from any of the other plots. This fruit is characterized by a thin rind, and is of excellent texture. Another characteristic of the deficient trees is premature dropping of the fruit. This begins in the summer so that much of the crop has been dropped by the time it is ready to be picked. Internal redistribution of potassium is known to occur readily and more or less continuously from the older plant organs to the younger ones. This characteristic undoubtedly accounts for the relatively long period of time it has taken for definite deficiency symptoms to show up in these trees.

Certain changes in the internal characteristics of the fruit as related to the potassium treatments have gradually been taking shape over a period of several years. The results of the analyses for 1946-47 have shown these changes more clearly in

some respects than ever before, Table II. The most consistent changes in the juice of the fruit as the potash fertilization increased was an increase in the citric acid content. This increase occurred, however, only when magnesium was adequately supplied. Where magnesium was deficient the acid content of grapefruit juice showed no consistent increase above the 3% potash treatment.

Changes in the soluble solids content of grapefruit show a similar trend as was shown for juice acidity except that the influence of the potassium treatment is slightly less pronounced. In the B Series where magnesium is supplied, there was a fairly sharp rise in solids from the 0% to the 3% treatment and a gradual increase from the 3% to the 10% treatment. Where magnesium was deficient the solids fell off noticeably in the 5% and 10% treatments.

As would be expected, considering the relationship of the potassium applications to the acidity and soluble solids content of the juice, the ratio was much higher from the zero potassium treatment and decreased as the potash applications increased. Fruit from the 0% plot passed the 7.00 to 1 ratio by September 30, whereas fruit from the 10% potash plots did not pass until October 30, a month later. The other treatments were intermediate between these dates.

Differences in the amount of vitamin C in the juice of fruit as related to potassium applications show the same trend that has been discussed for soluble solids. In many cases of fruit analyses there has been observed a very close correlation between the development of soluble solids and the formation of ascorbic acid. The vitamin C increased in the B series plots with the increase of the potash application and showed a sharp increase between the 0% and the 3% treatment. The seasonal averages show the fruit from the 0% plots contained an average of 35.8 mgs. of ascorbic acid per 100 mls. of juice while fruit from the 10% plots contained an average of 41.7 mgs., an increase of 14%.



# Maturity Analyses of Duncan Grapefruit as Affected by Varying Applications of Potash.

Sampling Date	% Citric Acid										% Total Soluble Solids										Ratio			
	0% K <sub>2</sub> O	3% K <sub>2</sub> O	5% K <sub>2</sub> O	10% K <sub>2</sub> O	0% K <sub>2</sub> O	3% K <sub>2</sub> O	5% K <sub>2</sub> O	10% K <sub>2</sub> O	0% K <sub>2</sub> O	3% K <sub>2</sub> O	5% K <sub>2</sub> O	10% K <sub>2</sub> O	0% K <sub>2</sub> O	3% K <sub>2</sub> O	5% K <sub>2</sub> O	10% K <sub>2</sub> O								
Sept. 17	1.06	1.38	1.30	1.40	8.65	8.63	8.05	8.26	8.16	6.27	6.19	5.87												
Sept. 30	0.99	1.29	1.25	1.25	8.55	8.38	7.93	8.10	8.68	6.68	6.34	6.50												
Oct. 15	1.15	1.20	1.22	1.26	8.65	8.59	8.35	8.35	7.52	7.18	6.87	6.69												
Oct. 30	1.09	1.18	1.15	1.16	8.80	9.13	8.40	8.75	8.11	7.74	7.34	7.66												
Nov. 12	0.915	1.15	1.14	1.18	9.20	9.47	8.90	8.87	9.89	8.32	7.81	7.56												
Seasonal Average	1.04	1.24	1.21	1.25	8.77	8.88	8.33	8.47	8.47	7.24	6.91	6.84												
Difference Necessary for Significance between Potash Treatments.																								
	% Citric Acid				% Total Soluble Solids				Ratio															
	5% level				5% level				1.056															
	1% level				1% level				1.424															

Sampling Date	% Citric Acid			% Total Soluble Solids						Ratio		
	0% K <sub>2</sub> O	3% K <sub>2</sub> O	5% K <sub>2</sub> O	10% K <sub>2</sub> O	0% K <sub>2</sub> O	3% K <sub>2</sub> O	5% K <sub>2</sub> O	10% K <sub>2</sub> O	0% K <sub>2</sub> O	3% K <sub>2</sub> O	5% K <sub>2</sub> O	10% K <sub>2</sub> O
Sept. 17	1.16	1.28	1.31	1.42	8.05	8.43	8.25	8.66	6.94	6.61	6.30	6.16
Sept. 30	1.05	1.22	1.05	1.34	8.25	8.43	8.38	8.58	7.86	7.93	6.59	6.40
Oct. 15	1.05	1.14	1.15	1.30	8.35	8.60	8.65	8.78	7.99	7.53	7.52	6.73
Oct. 30	0.97	1.12	1.29	1.39	8.80	9.20	8.90	9.40	9.07	8.24	7.48	7.30
Nov. 12	0.845	1.05	1.13	1.19	8.65	9.26	9.20	9.44	10.24	8.89	8.14	7.97
Seasonal Average	1.015	1.16	1.21	1.31	8.42	8.79	8.68	8.96	8.42	7.63	7.21	6.89

Difference necessary for significance between Potash Treatments.

	% Citric Acid	% Total Soluble Solids	Ratio
5% level	.120	.508	1.162
1% level	.162	.684	1.566

Differences between treatments as to the volume of juice extracted were not significant.

The question has been raised in view of these results, whether it would not be advisable to cut down or leave out entirely the potash from the summer fertilizer application, the object being, in the case of grapefruit, to reduce the acidity and produce fruit which would pass legal maturity earlier in the season. There is the further possibility that a lower arsenic application combined with such treatment might be effective and thus reduce the possibility of arsenic toxicity. On the basis of the past performance of these plots the evidence is against this idea working very satisfactorily. Kime (8) showed that potassium leaches out of most Florida citrus soils almost as rapidly as nitrogen. The present potassium applications were started in 1939; yet in spite of this fact there was little evidence of noticeable change in fruit quality before 1943, approximately four years later. It seems doubtful that the omission or the reduction of potash in a single application is going to affect the internal quality of the fruit to any very marked degree. A single year's data on a set of plots started by Dr. B. R. Fudge and carried on in cooperation with the Haines City Exchange shows no indication to date that such changes in potash fertilization would be effective.

#### TIMING OF OIL SPRAYS AFFECTS FRUIT QUALITY

The extent to which the timing of the oil spray will affect internal fruit quality has been discussed on several occasions this year, but since it is especially important for early oranges, a very brief summary of our results is given to complete this discussion. Low solids delayed shipment of the fruit from many Hamlin and Parson Brown groves in 1946 and the same thing is happening again this year. All of this trouble cannot be attributed to improper timing of the oil sprays. Where the timing was poor, the condition was made considerably

worse. In general, trends for the early oranges are similar to those reported earlier (13) for Pineapples, but the immediate effect to the grower, may in contrast, be very different. The market is usually best for Hamlins early in the season. Meeting color-added maturity standards then becomes paramount for Hamlins and Parson Browns, whereas this is generally not a serious problem for Pineapples or Valencias; their quality is reduced by improper timing of oil sprays but the fruit can still be shipped. Serious reduction in solids in early oranges, however, may result in the fruit never meeting minimum solids standards or at least not until late in the season. Of particular importance as shown by the results of several seasons are the following points:

(1) The best time to apply single, straight oil sprays to Hamlin oranges is between June 1 and July 15.

(2) Oil sprays applied August 1st and later cause lower solids than those applied during June and July.

(3) All double oil sprays reduce solids more than early single oil sprays.

(4) A proprietary copper-oil applied in early April and followed with a straight oil in June or early July has resulted in higher solids than other double oil sprays.

(5) Straight oil applied June 1 and followed with a second application July 15 is better than any other combination where straight oils as double sprays are used.

(6) Double oil sprays for Hamlin oranges should not be used unless the scale infestation is especially serious. In such cases, a copper-oil applied at melanose time, followed by a straight oil in June or early July is preferable. Where two straight oils are used, the June 1—July 15 combination or a close approximation of these dates has given best results.

(7) Double oil sprays requiring the second oil to be applied during the months of August and September should not be used for early oranges: the reduction in solids is too great.

In general these same statements apply to other orange varieties and to grapefruit. Grapefruit, however, is somewhat less responsive to oil treatments than oranges. Double sprays applied during August and September will result in lower solids fruit, but the effect from single applications of oil sprays during August and September generally does not cause as much reduction in solids for grapefruit as for oranges.

The best way to obtain good fruit quality is to maintain good tree condition. With the possible exception of arsenic for grapefruit, there is no good reliable short-cut to early maturity or high quality fruit. Location, weather conditions, root-stock, and the genetic constitution of the bud wood are all important factors in determining quality but are factors over which the grower has little control. Beyond this, careful attention to the spray program and the selection and careful following of an adequate and suitable fertilizer program which will maintain the grove in good physical condition is the best and most satisfactory way to insure production of high quality fruit.

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# VITAMIN C CONTENT AND JUICE QUALITY OF EXPOSED AND SHADED CITRUS FRUITS<sup>1</sup>

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## INTRODUCTION

That the vitamin C (ascorbic acid) content of a fruit is dependent upon the intensity of incident light was suggested by findings of Zilva and his associates (10) reported in 1935. These investigators found that the red peel of Bramley's Seedling apples contained twice as much vitamin C as the green peel. Although they did not mention light as a factor in the production of this difference in vitamin content, it is well known that the red side of an apple is normally the one that has been exposed on the tree to direct sunlight.

A review of the literature in 1936 failed to show that a comparison as to vitamin C content had been made between citrus fruits from shaded and exposed parts of the tree. It had long been common knowledge, of course, that shaded fruit degreens later than exposed fruit and sometimes never completely degreens and that its juice quality as judged by the taste test is not generally so high.

In 1936 an investigation was begun primarily to determine whether insolation influences the vitamin C content of Florida-grown citrus fruits; total soluble solids and total acid also were measured. The results of this study, terminated in 1943, are reported herein.

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In 1939 and 1940 Harding, Winston, and Fisher (4) (5) reported analyses indicating that Valencia and Lue Gim Gong oranges exposed to direct sunlight on the tree contained significantly more vitamin C than those not so exposed. In 1942 Harding and Thomas (6) reported that grapefruit obtained from the outside branches of the tree contained a little more vitamin C than that obtained from the inside branches.

## MATERIALS AND METHODS

In December, 1936, initial tests were made to determine the vitamin C content, total acid, and total soluble solids of Dancy tangerines (*Citrus reticulata* Blanco). Later, Temple oranges (supposedly *C. reticulata* x *C. sinensis*) and early, midseason, and late varieties of round oranges (*C. sinensis* (L.) Osbeck) were included in the study. Between 1936 and 1943 juice of 44 lot of round oranges from widely separated groves of the varieties Parson Brown, Hamlin, Pineapple, Indian River, Seedling, and Valencia, and of 7 lots of Temple oranges, and of 11 lots of Dancy tangerines from groves in central Florida were analyzed. The Temple oranges were grafted on rough lemon (*C. Limon* (L.) Burm. f.) or sour orange (*C. aurantium* L.)

Like numbers of exposed fruits and of shaded fruits were taken from the same trees. Each test sample consisted of the composited juice of 25 to 52 representative fruits of average size from 10 to 15 trees. The methods used for determining total soluble solids, total acid, and vitamin C were identical with those described by Harding, Winston, and Fisher (5) except that a Brix spindle was used to measure the total soluble solids.

## RESULTS

*Round Oranges*

The exposed fruits of each of the 6 varieties of round oranges contained on an average larger percentages of total soluble solids than did comparable shaded ones (table 1). For the 44 lots tested, regardless of variety, the average difference was 1.65 in percentage points, or 18.1 percent, which is mathematically highly significant.

Statistical analysis of the data on total acid revealed no significant difference between exposed and shaded fruit.

Exposed oranges were consistently higher in vitamin C than shaded fruit. The tests on 44 lots showed that on an average the outside fruit contained 0.09 mg. per milliliter more vitamin C than the shaded fruit, a difference of 20.9 percent. The results were highly significant statistically.

*Temple Oranges*

For the seven lots of Temple oranges analyzed, total solids were not significantly greater in the exposed than the shaded fruit. The difference amounted to 1.02 in percentage points, or 9.0 percent (table 2).

For four of the seven lots of Temple oranges, total acid was significantly higher in exposed fruit than in shaded fruit. On an average the acid content of the exposed fruit was greater by 0.049 percentage point.

The vitamin C content of Temple oranges averaged 0.08 mg. per milliliter, or 16.7 percent higher for the outside than for the inside samples. This difference was found to be statistically highly significant. As the samples were not collected to determine whether kind of rootstock had any effect, it is possible that they differed in other respects besides rootstock; but since Harding and Thomas (6) reported that grapefruit had a higher ascorbic acid content "but the difference was not significant" when the trees were grafted on rough lemon rootstock than when on sour orange, the reverse relation noted in this study is interesting.

*Tangerines*

In 11 lots of Dancy tangerines picked at various times during the 1936-37 harvest season and from several different groves, the outside (exposed) fruit consistently had more total soluble solids and more vitamin C than did the inside fruit, which was highly significant (table 2). There was less total acid in the outside fruit, and this difference was highly significant, though less marked than the differences in other constituents. On an average, the exposed fruit was 23 percent higher in soluble solids, 27 percent higher in vitamin C, and 16 percent lower in total acid.

## DISCUSSION

As oranges mature, normally there is an increase in total soluble solids and a decrease in acid. It seems logical to assume that oranges on the outside branches of the tree mature more rapidly than those on inside branches, since in the former the solids were found to be higher than in the latter. However, even after both types of fruit have attained full maturity, there is a vast difference in quality between the two. It seems likely that, just as most of the higher plants require direct sunlight for best growth and development, exposed branches produce better oranges than shaded ones.

The higher vitamin C content of the exposed oranges is no doubt a definite result of the incidence of sunlight. Other investigators (2) (3) (8) (9) (1) have reported instances in which it was evident that direct sunlight increased the vitamin C content of plants. Mention has already been made of the report of Silva and his associates (10) that the red peel of apples contained more ascorbic acid than did the green peel. Ezell and his associates (1) have shown that strawberries grown in the shade contained significantly less ascorbic acid than did those exposed to normal sunlight. Kohman and Porter (7) found that tomato plants set out in flats lost vita-

min C from stems and leaves when held in a laboratory in subdued light, but showed an increase in this vitamin when the flats were removed to the roof of the building.

In the past citrus growers have been warned against planting orange trees too close to each other, attention being directed to the fact that shaded fruit does not attain maximum color even when mature. This observation is most strikingly true of tangerines and of Temple oranges early in the season, but is not so marked when the fruit attains full maturity. The results of the present investigation indicate an additional reason for comparatively wide spacing of citrus trees, that is, to prevent unnecessary shading of fruit with consequent inferiority in general juice quality and in vitamin C content. This holds for round oranges, tangerines, and Temple oranges. During recent years there has been a rapid increase in the amount of citrus fruit canned, both as hearts and as juice. Juice quality rather than rind appearance determines the market value of citrus offerings to canneries. It is becoming more and more economically important to produce fruit of high nutritive quality as well as of attractive external appearance.

#### SUMMARY

In these investigations vitamin C content was found to be significantly higher in fruit from outside branches than in those from inside branches of the same tree. This was true for all varieties of round oranges studied, which included Parson Brown, Hamlin, Pineapple, Indian River, Seedling, and Valencia, as well as for Temple oranges, and for Dancy tangerines. Percentage of total soluble solids was significantly higher in the exposed fruit of all varieties tested. Total acid averaged somewhat higher in the outside Temple fruit than in that from the inside branches, while Dancy tangerines showed the reverse difference. Round oranges, including early, mid-season, and late varieties, showed no sig-

nificant difference in total acidity between fruit collected from inside and outside branches.

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TABLE 1—INFLUENCE OF INSOLATION ON TOTAL SOLUBLE SOLIDS, TOTAL ACID AND VITAMIN C (ASCORBIC ACID) CONTENT OF THE JUICE OF FLORIDA-GROWN ROUND

## ORANGES

Variety and date of test	Fruits tested		Total soluble solids		Total Acid		Vitamin C content	
	Exposed fruits	Shaded fruits	Exposed fruits	Shaded fruits	Exposed fruits	Shaded fruits	Exposed fruits	Shaded fruits
	Number	Number	Percent	Percent	Percent	Percent	Mg./ml.	Mg./ml.
Parson Brown:								
Nov. 10, 1938	50	52	11.33	9.53	1.284	1.190	0.62	0.50
Nov. 4, 1940	50	50	10.15	9.25	1.042	1.340	.62	.48
Nov. 15, 1940	50	50	10.60	9.33	.944	1.126	.53	.40
do	50	50	11.13	10.43	1.346	1.230	.51	.49
Average	50	50.5	10.80	9.64	1.154	1.222	.60	.47
Hamlin:								
Nov. 4, 1940	50	50	9.84	8.98	.940	.990	.57	.49
Nov. 15, 1940	50	50	8.93	8.43	.904	.948	.54	.45
Average	50	50	9.39	8.71	.922	.969	.56	.47
Pineapple:								
Dec. 17, 1937	55	51	11.33	9.53	1.284	1.190	.62	.50
do	45	44	9.98	8.73	1.190	1.280	.53	.45
Dec. 21, 1937	46	48	9.71	7.97	1.002	.990	.49	.41
do	51	50	9.46	8.91	1.158	1.054	.58	.50
do	50	51	10.66	9.23	1.434	1.422	.63	.55
do	52	51	10.66	9.20	1.430	1.422	.64	.55
Jan. 20, 1938	55	50	9.89	8.90	1.018	.984	.43	.34
do	52	53	9.50	8.10	.604	.535	.34	.28
do	50	50	11.79	9.84	1.130	.984	.48	.38
do	50	50	10.59	9.70	.981	1.022	.47	.39
Feb. 2, 1938	50	50	11.66	11.26	1.062	1.062	.59	.57
do	50	50	11.71	11.06	.928	.944	.57	.51
do	50	50	12.31	11.91	.978	.972	.56	.51
do	50	50	11.73	11.13	.872	.888	.56	.48
do	50	50	12.98	12.38	1.010	1.002	.63	.56
do	50	50	12.83	12.38	.900	.892	.53	.48
Nov. 20, 1940	50	50	11.62	10.62	1.266	1.324	.69	.52
Average	50.0	49.0	11.08	10.05	1.073	1.057	.55	.47
Indian River:								
Dec. 21, 1937	49	50	10.03	9.53	1.613	1.414	.51	.42
do	56	50	10.58	9.23	1.147	1.268	.39	.35
do	51	55	11.43	9.73	1.716	1.750	.52	.38
Average	52	51.7	10.68	9.50	1.490	1.477	.47	.38
Seedling								
Jan. 9, 1937	25	25	12.84	11.86	1.466	1.570	.62	.52
do	50	25	11.71	10.64	1.199	1.316	.62	.50
Jan. 23, 1937	25	25	12.53	11.43	1.138	1.272	.59	.50
Feb. 2, 1937	25	25	12.64	12.53	1.162	1.193	.59	.49
Average	31.3	25	12.43	11.62	1.241	1.338	.61	.50

Valencia:								
Jan. 9, 1937	25	25	10.64	10.11	1.870	1.864	60	.50
Jan. 16, 1937	25	25	10.21	8.11	1.217	1.126	53	.36
Jan. 23, 1937	25	25	10.03	8.83	1.074	1.220	50	.43
Feb. 13, 1937	25	25	10.50	9.70	1.094	1.142	.39	.32
do	25	25	9.90	8.50	1.122	1.074	.45	.34
Feb. 20, 1937	26	26	10.34	9.24	1.054	1.086	.49	.37
Mar. 13, 1937	26	27	10.67	10.00	1.094	1.070	.42	.34
do	31	26	10.90	8.67	1.022	1.002	.47	.36
Apr. 16, 1937	25	25	11.15	9.65	.960	.934	.38	.30
do	27	28	11.50	8.75	.908	.824	.47	.34
May 12, 1937	28	31	11.80	9.73	.904	.764	.39	.28
do	36	34	11.73	8.09	.774	.649	.43	.30
May 22, 1937	12	12	12.26	9.71	.690	.607	.43	.37
June 4, 1937	24	24	9.16	8.65	.592	.582	.39	.37
Average	25.7	25.6	10.77	9.12	1.027	.996	.45	.36
Average for all varieties								
	41	40.1	10.98	9.76	1.103	1.103	.52	.43

TABLE 2.—INFLUENCE OF INSOLATION ON TOTAL SOLUBLE SOLIDS, TOTAL ACID AND VITAMIN C (ASCORBIC ACID) CONTENT OF THE JUICE OF FLORIDA-GROWN TEMPLE ORANGES AND DANCY TANGERINES.

#### TEMPLE ORANGES

Date of Test	Fruits tested		Total soluble solids		Total acid		Vitamin C content	
	Exposed Fruits	Shaded Fruits	Exposed Fruits	Shaded Fruits	Exposed Fruits	Shaded Fruits	Exposed Fruits	Shaded Fruits
	Number	Number	Percent	Percent	Percent	Percent	Mg./ml.	Mg./ml.
Dec. 21, 1937	52	50	10.53	9.22	1.450	1.482	0.50	0.44
Jan. 20, 1938	53	55	11.89	11.09	1.205	1.070	.53	.45
Feb. 11, 1943	50	50	13.29	11.99	1.458	1.340	.68	.58
do	50	50	13.49	12.99	1.644	1.744	.58	.51
Average	51.3	51.3	12.30	11.32	1.439	1.409	.57	.50
Jan. 20, 1938	50	50	10.84	9.79	1.082	.928	.47	.38
Feb. 11, 1943	50	50	14.18	12.79	1.616	1.623	.59	.49
do	50	50	12.19	11.39	1.344	1.268	.58	.51
Average	50	50	12.40	11.32	1.347	1.273	.55	.46

#### DANCY TANGERINES

Dec. 12, 1936	27	27	9.63	7.80	0.912	1.086	.024	0.16
do	25	25	9.32	7.20	0.751	0.872	.26	.22
do	25	25	9.40	6.12	.666	.662	.31	.20
Dec. 22, 1936	25	25	10.30	8.10	.924	1.228	.37	.33
do	25	25	10.95	9.10	1.264	1.399	.44	.33
do	25	25	10.60	8.90	1.395	1.432	.29	.24
do	25	25	10.90	8.60	1.392	2.011	.35	.24
Jan. 9, 1937	25	25	10.61	8.21	.649	.908	.20	.18
Jan. 23, 1937	25	25	10.83	9.33	.710	.760	.20	.17
Feb. 6, 1937	25	25	11.29	9.75	.660	.714	.21	.16
Feb. 20, 1937	31	30	11.00	10.38	.662	.784	.20	.16
Average	25.7	25.6	10.44	8.50	.908	1.078	.28	.22



# 2-AMINO-PYRIDINE, A PROMISING INHIBITOR OF DECAY IN ORANGES<sup>1</sup>

## INTRODUCTION

Antiseptics have long been used for checking decay in citrus fruits. For this purpose they must possess high fungicidal properties, and at the same time be non-injurious to the commodity or to those who consume it over a long period. A number of chemicals that will give the desired degree of decay control are so toxic to animals that their use on foodstuffs is not permissible. Yet it is reasonable to assume that if the search is carried on long enough, someone will find an excellent decay inhibitor that meets all requirements of the health authorities.

With this objective in view, the U. S. Department of Agriculture Subtropical Fruit Field Station at Orlando, Florida, continued throughout the season of 1946-47 a search for an outstanding effective but safe material for treating citrus fruits to prevent the development of decay at any time during the marketing period. In the 1946-47 season several hundred compounds of established fungicidal or fungistatic properties, including a number of pyridine derivatives, were used in screening tests on oranges to determine their decay-inhibiting qualities. From this number several were outstanding for rot control, but the 2-amino-pyridine, hereinafter referred to as "2-AMP" for brevity, gave the most promising results.

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<sup>2</sup>The use of this material was suggested by the American Cyanamid Company, which supplied samples for screening tests.

Inasmuch as pyridine is a natural constituent of bone oil, there appeared some basis for suspecting that use of 2-AMP<sup>2</sup> might meet the requirement of being non-toxic. Concurrently with the execution of the tests reported herein, other agencies have initiated feeding experiments to ascertain whether the material could be applied to oranges without detriment to the consumers of treated fruit. These tests have not been completed, nor have the findings to date been released. Pending a determination of the toxicity of this material its use on fruit is not sanctioned. However, enough fruit-treating experiments have been executed to justify the release of a progress report on this phase of the study.

The first dipping tests made with this material at the Orlando laboratory were set up in early November, 1946. During the season more than 245 experimental lots totaling more than 13,000 fruits were used to evaluate 2-AMP as an inhibitor of decay in Florida oranges.

## EXPERIMENTAL PROCEDURE

These studies were confined almost exclusively to oranges that were ripe enough for market at the time of the testing under discussion. Such varieties as Parson Brown, Hamlin, Pineapple, Seedling, and Valencia, produced on mature trees, were used in their respective ripening seasons.

Upon delivery of the oranges to the laboratory from the groves, all lots of fruit were washed. While still wet they were transferred to a room maintained at 85°F. and 90 percent relative humidity. Here they were subjected to ethylene gas for 48 to 60 hours to accelerate the development of stem-end rot; however, the gassing treat

ment renders fruit less liable to green mold rot.

The fruit was treated within a few hours after the gassing period. Some lots were immersed for a fixed period of 10 seconds in varying concentrations of 2-AMP in water or in wax emulsion diluted to proportions commonly applied to citrus. In other experiments with a constant concentration of the antiseptic, the temperature of the bath was varied from 80° to 125°F., and in still other tests the length of the exposure to the bath ranged from 10 seconds to 3 minutes. None of the treated lots were rinsed subsequently to remove the adhering chemical. The dipped fruit was placed in trays to dry in open air, then transferred to a holding room.

Inasmuch as 2-AMP is somewhat volatile, it seemed advisable to explore the possibilities of applying this material to fruit in much the same manner as diphenyl, a volatile fungistat, by means of treated wrapping tissues or case liners. The wraps were treated by immersing them in an alcoholic or water-wax-emulsion solution of 2-AMP, hung on lines to dry, and then stored for future use. The first test with treated wraps was made March 11, 1947. The fruit was wrapped and packed in the usual manner, then transferred immediately to the holding room.

Some inoculation experiments with green mold, *Penicillium digitatum*, were conducted on oranges harvested and inoculated the same day. The fruit was washed, pricked with ten needles to depths of about 1mm., and dipped in a rich suspension of fresh spores taken from rotting oranges. The inoculated lots were held in a near saturated atmosphere at 70°F. for varying lengths of time before treatment with the antiseptic in wax emulsion. After application of 2-AMP, the fruit was surface dried in moving air and promptly placed in crates lined with paraffin paper, to assure the maintenance of an environment of high humidity, and promptly placed in the holding room, which was continuously maintained at about 80

percent relative humidity and 70°, a temperature favorable to the development of the principal rots of Florida citrus fruits. The uninoculated lots were inspected weekly over a period of three weeks, long enough to cover most marketing operations, while the inoculated oranges were inspected at intervals of three days over a nine-day period.

## RESULTS

*2-AMP in water or wax emulsion:* The preliminary tests with 2-AMP, ranging in concentration from 10 to 2-1/2 percent, in water as well as in a wax emulsion commonly used on fruit as a fruit dip, were repeated several times with early and mid-season oranges.

Inasmuch as all lots were subjected to ethylene gas, a treatment which is followed by less green mold than is ordinarily found in nongassed fruit, this rot developed in too small amounts even in the non-treated check lots to permit of safe interpretation. Therefore, only the data on stem-end rot (*Phomopsis citri* or *Diplodia natalensis*) will be considered in the initial tests.

Results reported in Table 1 show a remarkable control of stem-end rot by 2-AMP. In a water medium 10 percent 2-AMP gave the greatest control while 2 1/2 percent gave the least, and the difference in decay suppression between the 10 percent and 5 per cent solutions was not great. With fruit dipped in wax emulsion containing 2-AMP, the 2 1/2 percent solution was almost as effective as the 10 percent.

With these feeler tests on midseason oranges as a background, experiments were conducted with Valencia oranges immersed for 10 seconds in 5 and 10 percent 2-AMP in water. Similar concentrations of the chemical were incorporated in the water phase of the wax emulsion, as another practical method of application for commercial operations. Table 2 gives the results from six groups of 11 tests lots each.

In the series treated with 2-AMP in water, the miscellaneous decay, mostly side rot, was not of sufficient magnitude to be

consequential. The greatest amount of green mold, 3.1 percent was found in the untreated check, and the least, 1.3 percent, in the fruit treated with 10 percent 2-AMP. However, stem-rot increased in the water-dipped checks from 6.9 percent in 7 days to 53.8 percent a week later, and to 70.2 percent after another week. The fruit dipped in 5 percent 2-AMP in water had 2.4 percent, 2.5 percent, and 3.8 percent stem-end rot, at the end of the first, second and third weeks respectively, whereas 10 percent solution of 2-AMP gave 1.3, 2.0 and 2.5 percent. Decay from all causes finally consumed 73.8 percent of the untreated fruit, and 5.8 and 4.2 percent in the lots receiving the weaker and stronger concentrations of 2-AMP respectively. When similar proportions of 2-AMP were added to the emulsion, the resultant decay control was of very nearly the same magnitude as with the water solution.

A consideration not evaluated in the table above is chemical injury to the rind of treated fruit. A trace of brown, slightly sunken spots, probably chemical injury, was observed in three of the eleven lots, following the application of 5 percent 2-AMP in water. The blemish increased measurably but probably not importantly, commercially

speaking, during the holding period. No rind injury was observed on fruit receiving emulsion containing 5 percent 2-AMP. However, the 10 percent solutions in emulsions as well as in water caused an appreciable amount of rind injury which increased in number of affected fruits with the extension of the holding period, and which doubtless was present in sufficient proportions to be commercially significant. Rind injury developed more on the fruit treated with water solutions than on that treated with an emulsion containing the antiseptic.

*2-AMP in water dip for 10 seconds, 1 minute, 3 minutes:* In another series of experiments with gassed oranges, table 3, a 5 percent water solution of 2-AMP was applied to the fruits for 10 seconds, 1 minute, and 3 minutes, respectively, at a uniform concentration of 5 percent. In none of the lots did the miscellaneous wastage, mostly side rots, amount to as much as 2.0 percent, even after 3 weeks' holding. Likewise, green mold increased to only 2.4 percent in the check fruit, and to not more than 1.6 percent in the treated lots. In the case of stem-end rot, decay control was very effective with no significant differences due to the duration of the dip.

Not more than a trace of rind injury was

TABLE 1—TOTAL STEM-ROT IN GASSED EARLY AND MIDSEASON ORANGES DIPPED IN SEVERAL CONCENTRATIONS OF 2-AMINO-PYRIDINE — HELD 6 WEEKS AT 70° F

Treatment	No. Tests	No. Fruit	Stem-end Rot
			Percent
Check — water	3	75	57.3
10% 2-amino-pyridine in water	3	75	1.3
Check — water	9	242	65.3
5% 2-amino-pyridine in water	9	241	4.1
2 1/2% do	9	244	9.4
Check — emulsion	4	100	47.0
10% 2-amino-pyridine in water	4	100	4.0
5% do	4	100	3.0
2 1/2% do	4	100	5.0

TABLE 2.—DECAY IN GASSED ORANGES TREATED WITH 2-AMINO-PYRIDINE (10 SECOND DIP, NO SUBSEQUENT RINSING)  
Orlando, Florida—Spring, 1947

Treatment	No. Tests	No. Fruit	1 week at 70°F.				2 weeks at 70°F.				3 weeks at 70°F.			
			SER*	Percent			SER	Percent			SER	Percent		
				SER*	Pen.	Misc.		SER	Pen.	Misc.		SER	Pen.	Misc.
Check in water	11	550	6.9	0.4	0	7.3	53.5	2.7	0.4	56.9	70.2	3.1	0.5	73.9
5% 2-AMP in water	11	550	2.4	0	0.1	2.5	2.5	0.7	0.4	3.6	3.5	1.6	0.4	5.8
10% 2-AMP in water	11	550	1.3	0	0.1	1.4	2.0	0.4	0.3	2.7	2.5	1.3	0.4	4.2
In wax emulsion check	11	550	8.0	0.2	0.2	8.4	56.4	0.9	0.3	57.6	73.8	2.0	0.6	76.4
5% 2-AMP in wax emulsion	11	549	1.3	0.2	0.1	1.6	2.0	1.1	0.5	3.6	2.5	2.7	1.2	6.4
10% 2-AMP in wax emulsion	11	550	0.2	0	0.2	0.4	0.7	1.1	0.2	2.0	0.9	2.6	0.7	4.2

\* SER—Stem-end rot (*Diplodia natalensis* or *Phomopsis citri*).

Pen.—Green mold (*Penicillium digitatum*).

Misc.—Miscellaneous rots other than SER or Pen.

detected in a few of the dipped fruits, and it was not in sufficient amount in any test to be of commercial significance; in fact, the injury may have been due to some factor other than the antiseptic.

**2-AMP at 80°, 100°, 125°F.:** Still another series of experiments was run to determine whether the fungicidal properties of 2-AMP could be increased by raising the temperature of the treating bath from 80° to 125° F. The time of exposure was 2 minutes in all cases. Two water check temperatures, 80° and 125°, were selected since they represented the extreme limits at which the antiseptic was applied. Table 4 gives the different categories of decay cumulatively.

Again the miscellaneous decay, mostly side rot, was of no consequence since the maximum amounted to only 2.2 percent after a 21-day holding period; likewise green mold, which developed to some extent in all treatments, was of minor importance since the maximum after 3-weeks' holding was only 2.5 percent.

In the 80°F. water checks there was slightly more stem-end rot at the first, second, and third inspections, respectively, than at the corresponding inspection of the 125° check.

In the case of the fruit treated with 5 percent solution of 2-AMP, a progressive but slight decrease in stem-end rot was observed at each of the weekly inspections as the temperature of the bath was raised from 80° to 100°, and then to 125°F., the last temperature being that at which the usual commercial color-added or dye treatment is applied.

**Various other tests with 2-AMP:** Supplementary tests were set up to determine whether: (1) aqueous solutions of 2-AMP would deteriorate rapidly on standing; (2) it would mix with solutions used for the color-added treatment; (3) it would be compatible with the wax emulsion in common use; (4) a spreading agent would increase its efficacy; and (5) wrapping tissue, treated with this material would check decay.

**Re-use of 2-AMP:** Results from three

tests indicate that an old (used) water solution of 5 percent 2-AMP was about as effective after one and two weeks' standing as when freshly prepared. The non-treated lots had 64.5 percent total decay; those treated with fresh solution developed 5.6 percent; and those treated with a 2-weeks-old solution, 6.5 percent in three weeks.

**2-AMP in dye:** The antiseptic apparently was not impaired when mixed with the "color-added" dye solution, nor was there any apparent change in the coloring properties of the dye, as indicated in two tests in which no decay developed in treated lots while 42 percent decay was noted in the check lots.

**2-AMP with wax emulsion.** The antiseptic mixed well with seven lots of wax emulsion used on fruit and retained usual decay-repressing properties.

**2-AMP with spreading agent.** Evidence obtained from four tests indicated that decay-inhibiting properties of 2-AMP were not increased by the addition of 0.1 percent of Vatsol O. T. The average of four tests gave 53.5 percent total decay in three weeks in untreated check lots, 7.8 percent in the lots treated with 5 percent 2-AMP in emulsion, and 9.0 percent where the spreader was added.

**2-AMP in wrapping tissue:** Plain wrapping tissue impregnated with a 10 percent solution of 2-AMP in isopropyl alcohol was moderately effective in checking decay in three lots of dead-ripe Seedling oranges in March as is shown by the average of three tests. After three weeks' holding the fruit in untreated wraps had developed 44.8 percent stem-end rot and 27.6 percent green mold, while that in treated wraps showed 9.8 percent stem-end rot and 5.8 percent green mold. Decay from all causes amounted to 73.7 percent in the check lots and 18.6 in the treated fruit. It is interesting to note that considerable rind injury characterized by scattered brown, slightly sunken spots developed slowly in each of the lots wrapped in treated tissues. This blemish was not noticeable until after the first week.

TABLE 3.—DECAY CONTROL IN GASSED ORANGES TREATED WITH 5 PERCENT 2-AMINO-PYRIDINE IN WATER FOR VARYING LENGTHS OF TIME.

Treatment	No. Tests	No. Fruit	1 week at 70°F.				2 weeks at 70°F.				3 weeks at 70°F.			
			SER	Pen	Misc.	Total Decay	SER	Pen.	Misc.	Total Decay	SER	Pen.	Misc.	Total Decay
Water check 10 seconds	11	548	4.9	0	0	4.9	47.4	1.6	0.3	49.3	67.7	2.4	0.2	70.3
2-amino-pyridine 10 seconds	11	548	1.8	0	0.2	2.0	2.6	0.5	0.9	4.0	4.0	1.6	1.7	7.3
2-amino-pyridine 1 minute	11	549	1.6	0	0.6	2.2	1.8	0.9	0.8	3.5	4.6	1.5	1.0	7.1
2-amino-pyridine 3 minutes	11	550	1.8	0	0	1.8	2.9	0.4	0.7	4.0	4.7	1.6	1.7	8.0

\* SER—Stem-end rot (*Diplodia natalensis* or *Phomopsis citri*).Pen.—Green mold (*Penicillium digitatum*).

Misc.—Miscellaneous rots other than SER or Pen.

TABLE 4—DECAY IN GASSED ORANGES TREATED WITH 5 PERCENT 2-AMINO-PYRIDINE SOLUTION IN WATER (2 MINUTE DIP, NO SUBSEQUENT RINSING).

Temperature of treatment variable.

Treatment	No. Tests	No. Fruit	1 week at 70°F				2 weeks at 70°F				3 weeks at 70°F			
			SER*	Pen.	Misc.	Decay	SER	Pen.	Misc.	Decay	SER	Pen.	Misc.	Decay
Water check 80°F.	11	558	6.3	0.4	0.1	6.8	48.7	1.4	0.4	50.5	71.3	1.5	0.6	73.7
			3.4	0.2	0	3.6	39.0	1.0	0.1	40.1	65.0	1.5	0.2	66.7
Water check 125° F.	11	526	1.6	0	0.4	2.0	2.7	0.2	0.7	3.6	3.4	0.9	2.2	6.5
			1.1	0.2	0.3	1.6	1.8	0.9	0.9	3.6	2.7	2.5	1.6	6.8
2-amino-pyridine 80°F.	11	555	0.5	-0.4	0	0.9	0.7	0.7	0.2	1.6	1.4	1.4	0.8	3.6
2-amino-pyridine 100°F.	11	557												
2-amino-pyridine 125°F.	11	556												

\* SER—Stem-end rot (*Diplodia natalensis* or *Phomopsis citri*).Pen.—Green mold (*Penicillium digitatum*).

Misc.—Miscellaneous rots other than SER or Pen.

Somewhat later, during the Valencia season, plain wrapping tissue was treated with 5 percent and 10 percent 2-AMP in wax emulsion. After drying, these wraps were used with three lots of fruit.

After 21 days 73.3 percent decay from all causes had developed in the check fruit. Of this 72.0 percent was stem-end rot and 1.3 percent green mold. In the same length of time 10.7 percent stem-end rot, 2.0 percent green mold, and 0.6 percent decay from all other causes appeared in the fruit wrapped with tissue dipped in wax emulsion containing 5 percent 2-AMP.

The control of decay in fruit covered with tissue impregnated with 10 percent 2-AMP in wax emulsion was no greater than with that in the wraps with the weaker dosage, to wit, there was 14 percent rot from all causes, of which 13.3 percent was stem-end rot and 0.7 percent green mold.

*Inoculation experiments with 2-AMP and with sodium ortho-phenyl-phenate.* Inoculation experiments were initiated in which freshly wounded oranges were inoculated with spores of the green mold fungus and later treated at intervals with a 5 and a 10 percent solution of 2-AMP in wax emulsion. In a similar series of experiments 1 1/4 percent sodium ortho-phenyl-phenate was added to the wax emulsion. The results of the tests, conducted under more extreme conditions than are likely to prevail in commercial practice, are given in Table 5.

Under these extreme conditions fruit treated with 10 percent 2-AMP in wax emulsion within a few hours after inoculation held up well for nine days. A progressive decrease in decay repression was noted with the increase of the time interval between inoculation and antiseptic treatment. When the concentration of 2-AMP was reduced to 5 percent its mold inhibiting properties were greatly weakened.

Under the same extreme conditions 1 1/4 percent sodium ortho-phenyl-phenate failed to give a lasting protection against green

mold development, although it retarded spoilage more effectively than 5 percent 2-AMP. It is interesting to note that when the antiseptic was applied 8 hours after inoculation, the repression of decay was more effective than when the application was made at a greater or less interval after inoculation. In none of the separate tests was the decay development 9 days after inoculation greater in the lots receiving the antiseptic 8 hours after inoculation than in those treated 4 hours after. There seems to be no satisfactory explanation for this phenomenon, which occurred on 9 separate occasions.

#### DISCUSSION

The need for some effective means of checking decay in Florida citrus fruit becomes obvious when it is seen that decay developed in approximately 50 percent of the untreated oranges in 2 weeks. While this rate is abnormal, it is sometimes encountered in commercial operations, especially when the fruit is ripe.

Inasmuch as 2-AMP is a derivative of pyridine, which in turn is found in considerable quantities in bone oil, there may be some basis for assuming that it may prove to be acceptable material for treating fruit for the prevention of decay.

For these tests no fruit drying facilities were available so all treated lots were placed in trays and set in the open air to dry. Sometimes the fruit dried rather quickly, but at other times, especially in cloudy or inclement weather, the drying time was several hours. Therefore, since injury is probably related to the length of time the fruit remained wet with the solution, it is probably unwise to place much emphasis on the rind injuries or to draw conclusions relative to the danger thereof in treatments given under commercial handling conditions.

The 2-AMP antiseptic mixes well with the general run of wax emulsions commonly applied to citrus fruits, as well as with



water. Used solutions retained their effectiveness after standing for at least 2 weeks. An effective application can be made by passing the fruit through a small tank containing 5 percent solution 2-AMP in wax emulsion or in water, or probably by flooding the solution on fruit for a few seconds in order to assure a thorough coverage. The material also is compatible with the dye used in the color-add treatment.

The evidence presented herein, although not closely paralleling that reported by E. F. Hopkins and K. W. Loucks in the June, 1947, issue of *Citrus Industry*, tends to substantiate their findings. These two investigations were conducted almost simultaneously but independently and with fruit from different sources and under different conditions.

Conspicuous absence of green mold rot in the Valencias was not unexpected, since

the prevalence of this rot regularly diminishes in the spring and summer. There appears no basis for assuming that the Valencia orange is less susceptible to green mold than the winter-ripening varieties which fall a ready prey to it. The decline in the incidence of green mold in the spring seems to be associated with warmer weather and perhaps with less favorable humidity conditions.

A ten percent concentration of 2-AMP was effective in checking green mold in inoculated oranges, but neither 5 percent 2-AMP nor 1 1/2 percent sodium ortho-phenyl-phenate checked green mold rot in inoculated fruit satisfactorily under the conditions of the test; yet it is well known that the latter gives an excellent control of the rot under commercial conditions, which are far less harsh than those set up for the tests reported herein.

TABLE 5—DEVELOPMENT OF GREEN MOLD IN INOCULATED ORANGES TREATED WITH WAX EMULSIONS CONTAINING 2-AMINO-PYRIDINE AND WITH SODIUM ORTHO-PHENYL-PHENATE.

Treatment	No. Tests	No. Fruit	Hours between inoculation and Treatment	Days at 70°F.		
				3	6	9
				Percent infection		
Check emulsion	3	78	8	83.3	100.0	100.0
10% 2-amino-pridine	3	79	4	0	1.3	2.5
do	3	78	8	1.3	2.6	6.4
do	3	79	16	3.8	8.9	10.1
do	3	79	24	15.2	34.2	40.5
Check emulsion	6	228	8	94.3	100.0	100.0
5% 2-amino-pyridine	6	228	4	7.0	24.6	37.3
do	6	228	8	7.5	18.4	27.6
do	6	229	16	27.9	52.4	56.8
do	6	227	24	52.9	70.9	75.3
Check emulsion	3	150	8	99.3	100.0	100.0
1 1/4% Dow A*	3	150	4	1.3	14.7	26.0
do	3	150	8	0	9.3	18.0
do	3	151	16	2.0	24.5	29.1
do	3	152	24	15.8	46.7	53.3

\* Dow A—sodium ortho-phenyl-phenate.

Applying 2-AMP to wrapping tissues seems to be a promising method of application, especially since it does not bring about an attachment of the fungicide in a solid state to the fruit. Although 2-AMP has an odor, its presence on fruit could not be detected by smelling, nor did it affect the flavor or appearance of the juice of treated fruit.

#### SUMMARY

A 5 percent solution of 2-amino-pyridine (2-AMP) in water or in wax emulsion, applied to oranges after a 50 to 60-hour exposure to ethylene gas, gave very good to excellent control of decay in Florida oranges.

Plain wrapping tissue impregnated with

2-amino-pyridine was effective in checking decay in seedling and Valencia oranges.

Because of the relative absence of *Penicillium* rot during the period when the principal tests were made, the evidence of effectiveness against that fungus is not so striking as against the stem-end rot fungi.

Limited evidence based on inoculations indicates that weak concentrations of 2-AMP may not be quite so effective as sodium ortho-phenyl-phenate against green mold for a short period. 2-AMP did not affect the flavor or appearance of the juice of treated oranges.

The feasibility of commercial use of 2-AMP on citrus fruits, from the standpoint of possible toxic effects on consumers, has not as yet been determined.

## PREVENTION OF ENTRANCE OF INSECT PESTS AND DISEASES FROM FOREIGN COUNTRIES

ARTHUR C. BROWN

*Plant Commissioner, State Plant Board  
Gainesville*

It is unfortunate indeed that the speaker scheduled for this period, Mr. Arthur G. Watson, Assistant Collector of Customs, Tampa, Florida, is not able to be here and present a picture of foreign plant quarantine as viewed by one not primarily engaged in plant quarantine enforcement.

The activities of Customs and plant quarantine enforcement inspectors are closely related. The former are responsible for the regulation of entry of foreign commodities, largely from a revenue angle, while the latter are responsible for regulation of entry of plants and plant products to protect the agricultural interests of the United States from economic losses, sometimes of serious proportions, likely to follow entry of affected plants, fruits, etc., from foreign

countries. As a matter of fact, rigid enforcement of Customs regulations would deny plant quarantine inspectors the right to board any newly arrived air-or water-craft, or even inspect plants until after Customs had completed entry of the craft and officially disposed of its cargo. It is apparent that a procedure of this nature would seriously interfere with the efficient application of plant quarantine regulations.

Mr. Watson, a grove owner himself, has been intensely interested in foreign plant quarantine enforcement since the inception of this branch of the Plant Board's activities in 1916 and has done everything within his authority to provide for the closest co-operation of Customs inspectors. This has resulted in a situation whereby the number of plant quarantine inspectors at Florida ports of entry totals not the number of Plant Board employees assigned any particular port, but the combined number of Plant

Board and Customs inspectors at that place. This happy combination of effort has been the envy of other state and federal plant quarantine officials.

The 1947 Legislature provided the funds requested by the Plant Board for operations during the biennium 1947-49. It is believed that the Board's Nursery and Quarantine Departments are operating effectively. This is true of the Grove Inspection Department in so far as the present personnel is concerned. However, it has been most difficult to find a sufficient number of qualified individuals to fill all of the positions provided for in the Grove Inspection budget. If any of you know of anyone familiar with insects and diseases and their control and well informed as to citrus culture who may be interested in obtaining employment with the Board's Grove Inspection Department, please refer him to the Plant Commissioner at Gainesville.

You are all interested in the possibility of entry of destructive citrus pests, particularly from foreign countries. Federal plant quarantines prohibit entry of citrus trees, budwood, etc., from foreign countries. Citrus fruits are prohibited from most foreign countries. The Board's regulations prohibit entry of all citrus trees, budwood, etc., from other states in the Union. Lemons only are permitted entry—after treatment designed to eliminate risk of entry of brown rot—from California and treated lemons and oranges are permitted from Arizona. All citrus fruits from other states are denied entry into Florida.

It is easy to promulgate regulations seeking to prohibit entry of certain commodities; it is far more difficult to enforce such regulations, particularly domestic quarantines. I do not believe that any of you will be surprised when it is stated that the tremendous development of motor vehicle transportation has made enforcement of domestic plant quarantines, except in well planned and administered eradication projects, almost impossible. Therefore, so long as there persists in any part of the United States any major

insect or disease affecting citrus the citrus industry of Florida is in jeopardy.

All of you know that as a result of state-federal eradication activities official announcement was made about fifteen years ago of the eradication of citrus canker from Florida, Alabama, and Mississippi. Similar announcement has never been made with respect to eradication in Louisiana and Texas, where federal-state eradication campaigns were in effect about 1944. At that time lack of appropriations made necessary discontinuance of the federal participation. Louisiana and Texas officials have, to the best of their ability, continued the project. The situation in the two states at the time federal aid was discontinued was essentially as follows:

Citrus canker infected trifoliata trees had been found in the old Satsuma area in the vicinity of Galveston and Houston, Texas, in 1943, and in one planting located south of New Orleans, Louisiana, in 1940. (No citrus canker has been reported from the Rio Grande Valley since 1917.)

The Texas Legislature in 1947 appropriated \$40,000 for completion of citrus canker eradication in that state. Although the Bureau of Entomology and Plant Quarantine has not been able to obtain Congressional appropriations for canker eradication, Bureau officials have been able to allot some \$15,000 from other sources and cooperative eradication activities are again under way in Texas, but not in Louisiana.

Another development of which you should be informed is the rapid movement northward through Mexico of the spiny citrus whitefly, or blackfly (*Aleurocanthus woglumi* Ashby), a pest that has demonstrated its destructive nature in Cuba and the Bahamas, where citrus trees were either killed or severely injured. The infestation in Mexico has aroused the apprehension of citrus growers in Texas, Arizona, and California, who fear that unless the northward spread is checked blackfly will invade these states. The California Department of Agriculture has made arrangements with officials of the

Mexican government whereby California entomologists will go into the infected areas in Mexico and attempt to bring blackfly under control.

This insect is now effectively controlled in Cuba and the Bahamas by parasites and predators introduced from India by our federal Department of Agriculture. (Incidentally, your State Plant Board was largely responsible for interesting authorities in introducing these natural enemies.) We are informed that attempts to introduce parasites into Mexico have not been successful. We are not informed as to whether this attempt was made by specialists of the United States Department of Agriculture or by growers in Mexico. It is imperative that a determined attempt to control blackfly in Mexico be made before it spreads into the southwestern states. Once established there, it is bound to spread eastward and eventually into Florida.

You will be interested also in contemplated changes in the manner of inspection of passengers and baggage from foreign countries now being considered by the Bureau of Entomology and Plant Quarantine, the federal agency responsible for enforcement of foreign plant quarantines. Arrangements have already been made for the inspection at Honolulu of passengers and baggage from the Orient, New Zealand, and Australia, en route to the continental United States via Honolulu. Following the inspection at Honolulu, passengers will be allowed, after arrival on the mainland, to proceed to their destinations without further inspections. Now under consideration is the inspection at San Juan, Puerto Rico, of passengers and baggage destined for the United States, and similar inspection at Mexico City, Mexico, of passengers entering the United States through that country.

The thought behind this inspection at foreign points instead of at ports of entry is an excellent one. Such inspection, together with confiscation of contraband or pest-ridden plants or fruits, should prevent the entry of such material into this country.

But there may be some question as to the wisdom of assigning to individuals located a thousand or more miles away the important task of protecting Florida's agricultural and horticultural interests from invasion by alien plant pests. Such inspection must be performed by federal inspectors. These federal inspectors will be charged with the responsibility of protecting the entire United States, and not one particular state or section. Their procedure must of necessity be a uniform one. Unfortunately, because of the wide diversity of climate and flora in the United States, uniformity of inspection of commodities moving into this country is not practical. It is for this reason that the State Plant Board has supplied funds and personnel for practically all foreign plant quarantine enforcement in Florida since 1916. Your Plant Board has protested against the substitution of inspection at San Juan, Puerto Rico, for inspection at the ports of Florida, and has requested federal authorities to consult with the Board and growers in Florida before making effective any change in the current inspection practices.

It is my suggestion that the Florida State Horticultural Society give thought to the desirability of adopting resolutions addressed to the appropriate federal authorities on the following subjects:

1. Need for federal appropriation to carry on state-federal citrus canker eradication activities in Louisiana and Texas until such time as officials feel justified in making announcement that the disease has been eradicated from those two states.
2. Need for federal cooperation with Mexican authorities in the control or eradication of blackfly in Mexico.
3. The need for conferences between the State Plant Board and growers'

organizations in Florida on one hand, and officials of the Bureau of Entomology and Plant Quarantine, United States Department of Agri-

culture on the other, before any change is made in the present manner of inspecting passengers and baggage from Puerto Rico.

## GRASSHOPPER CONTROL IN CITRUS GROVES IN FLORIDA

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In May, 1947, grasshoppers of the species *Schistocerca americana* (Drury) were reported as doing damage in citrus groves in southeastern Hillsborough County. Since this grasshopper was formerly thought to cause damage only in the fall of the year, the situation was regarded as abnormal and potentially serious. A survey indicated that grasshoppers were abundant over a fairly wide area and that some control measures would be necessary. The following is an account of the 1947 infestation and a review of the control program proposed for this pest.

In the fall of 1946, heavier than normal populations of grasshoppers were present in western Polk and southeastern Hillsborough Counties. Benzene hexachloride was used as a dust (0.6% gamma isomer) and as a spray at the rate of 2 to 3 pounds of wettable powder (6% gamma isomer) per 100 gallons of spray. This proved to be an effective control measure. In January and again in March of 1947 casual observations were made and it was noted that adult grasshoppers were in the fields. It is not known at present whether these represented relatively newly emerged adults or

whether they were left from the fall generation. The fall of 1946 was abnormally warm and it is suggested here that there may have been at least a partial or possibly a complete extra generation in the fall. In any case it appears that the warm fall and winter offered favorable overwintering habitats and this was a major factor in the abnormal increase in grasshopper numbers in 1947.

There was a heavy hatch of grasshoppers about May 1, 1947. The last of May showed a population which was generally about 1/3 to 1/2 grown. By late June a few of these individuals had grown wings and were present as adults. Adults continued to mature and in late July most of the grasshopper population was in the adult stage. There was some oviposition in late July and eggs began to hatch shortly after August 1. Through the cooperation of the Bureau of Entomology and Plant Quarantine, Mr. Andrew Frazier came into the state in July and he was able to make a thorough survey of the infestations. He found the grasshoppers mainly in the area south of Plant City in Hillsborough County, both north and south of Lakeland in Polk County, and in scattered places from Bartow to Wachula in Polk and Hardee Counties. There were occasional infestations on the east coast, but they were of minor importance. In the central part of the state, it appeared that grasshopper infestations were associated with areas where crab grass was the predominant type of cover crop and where groves were adjacent to old vegetable fields. Groves had become infested both from adja-

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cent fields and from hatch within the grove itself.

The second generation of hoppers hatched throughout August with the bulk of the hatch occurring between August 15 and August 25. From 50 to 100 individuals hatched from each egg pod and these remained clustered together in a colony for more than a week. These nymphal grasshoppers grew and began to reach maturity in mid-September. October 10 marked the peak of maturation and following that date the bulk of the population was present as adults. Up to November 1, no copulation or oviposition has been observed in the field. Whether a partial third generation may occur remains to be determined. Damage was most serious in June and early July and again in September and October. These periods coincided with times when young grasshoppers were more than half grown. Apparently they feed most heavily at that time in their life history. As very small individuals and as adults they do a minimum of damage to citrus foliage.

#### CONTROL BY INSECTICIDES

A review of recent literature on grasshoppers control (Hinnman, 1947; Weinman, 1947; and List, 1947) indicated that 3 new chlorinated hydrocarbons were showing promise for grasshopper control. These were benzene hexachloride at about 0.3 lbs. of gamma isomer per acre, chlordane at 1.0 lb. per acre and chlorinated camphene at 3.0 lbs. per acre. These dosages are arbitrary averages, but they seem to represent approximate figures at which other workers were obtaining control. Since citrus groves ordinarily require more spray or dust than vegetable or field crops, it was decided to try these materials for toxicity to grasshoppers and if they appeared satisfactory, they would be applied at the rate of 50% more toxicant per acre than the figures cited above. A total of 9 experiments were performed on a field scale. Plots varied in size from 1 to 5 acres. These tests were performed between July 15 and October 25.

The first 2 experiments were performed in mid-July in a grove where a heavy grasshopper population was present. The dusts were applied by airplane both in the grove and in adjacent grasslands. It was determined from these preliminary tests that an airplane flying each middle of a grove was a satisfactory method of application for grasshopper control; benzene hexachloride, chlorinated camphene, and chlordane were satisfactory toxicants; and that results were much better where the cover crop was chopped prior to treatment.

Only 1 experiment is being reported in detail. In this test 4 materials, chlordane, chlorinated camphene, benzene hexachloride, and thiophos 3422, were used both as wettable powders and as dusts. The grove was composed of large grapefruit and orange trees and each plot contained 2 acres. Sprays were applied by a "Speed Sprayer" and dusts with a conventional ground duster. Treatments were randomized and they were adjacent to each other. In all instances the cover crop was chopped prior to spraying or dusting. Treatments were applied on the mornings of August 18 and 19. All 8 treatments gave excellent initial mortality. Counts were made by counting the number of adults seen while walking through a given number of rows. Initial populations found in the adjacent untreated areas were taken as standards and all percent reductions were based on these figures. Table I shows the dosages and the percent reductions at 3 intervals following the treatment. After 7-8 days the populations in the adjacent untreated areas were materially reduced. This was undoubtedly at least partly due to migration into the treated plots. It will be noted that chlordane and chlorinated camphene gave more prolonged control than did either benzene hexachloride or thiophos 3422. This fact was also substantiated by caging adult grasshoppers from each of the plots and observing mortalities at 24 and 48 hours after caging. No treatment was successful in preventing reinfestation from adjacent areas for more than a few days.

This fact emphasizes the importance of treatment not only of an infested grove, but of adjacent areas as well, if completely satisfactory control is to be obtained. In cases where both the grove and adjacent grasslands were treated in July, no further damage was done and the second generation produced only an occasional hopper in the area.

The experiment reported in detail above was typical of the results obtained elsewhere. Several factors were demonstrated conclusively by observations on these controlled experiments and also by observations where commercial groves were treated by caretaker or owners. Thiophos 3422 is not further considered in this paper because of its non-availability at present and because too little is known concerning its toxicity to fruit and to warm blooded animals. As

later experiments developed, it was evident that some slight modifications could be made in the dosages noted in Table I. Table II shows the toxicant per acre required for control and the amount of dilute material for some of the standard formulations. All recommendations are based on pounds of actual toxicant per acre. Although this is a departure from usual recommendations for spray or dust on citrus, it was definitely established that this method works satisfactorily. The only requirement is that the material be dispersed evenly over both the trees and the cover crop. In young groves that are clean cultivated or in open fields the dosage may be reduced about 33 percent and still give satisfactory control. Dusters should be driven slowly and the dust applied primarily to the lower 6-8 feet of the tree and to the cover crop.

TABLE I.  
CONTROL EFFECTED BY FOUR SPRAYS AND DUSTS ON GRASSHOPPERS IN A CITRUS GROVE

Treatment	Lbs. Toxicant per acre	% Reduction After—		
		1 day	3-4 days	7-8 days
Chlordane spray <sup>1</sup>	1.5	95	82	81
Chlordane dust <sup>2</sup>	1.5	94	94	89
Chlorinated Camphene spray <sup>3</sup>	4.5	94	96	89
Chlorinated Camphene dust <sup>4</sup>	4.5	96	96	83
Benzene Hexachloride spray <sup>5</sup>	0.45	98	89	71
Benzene Hexachloride dust <sup>6</sup>	0.45	87	91	68
Thiophos 3422 spray <sup>7</sup>	0.45	96	90	74
Thiophos 3422 dust <sup>8</sup>	0.45	92	91	71
Untreated		0	0	71

<sup>1</sup> 50% wettable

<sup>2</sup> 5% dust

<sup>3</sup> 33 1/3% wettable

<sup>4</sup> 10% dust

<sup>5</sup> 6% wettable

<sup>6</sup> 1% dust

<sup>7</sup> 15% wettable

<sup>8</sup> 1% dust

All spray recommendations in this paper are based upon the use of a "Speed Sprayer." The number of gallons to be used per acre may vary from about 100 to as high as 1000 gallons. The number of gallons to be used per acre should be established first and sufficient insecticide added to the tank to insure the required amount of toxicant per acre. The authors obtained excellent results by using a double head with all the top nozzles cut off and with only about 25 nozzles open on each side. The sprayer was driven at less than 2 miles per hour and 500 gallons of solution were used per acre. The number

be used with oil. Chlordane and chlorinated camphene were found to be satisfactory when used as emulsifiable materials as well as in wettable form.

In choosing the insecticide to use, several factors should be considered. Since all are effective, cost per acre should be taken into account. Chlordane and chlorinated camphene have greater residual toxicity, but present results do not indicate that this is of major importance. According to work in 1947, chlordane and chlorinated camphene may be used at any time. *However, benzene hexachloride should not be used on*

TABLE II.

RECOMMENDED DOSAGES FOR THREE MATERIALS TO BE USED FOR GRASSHOPPER CONTROL IN CITRUS GROVES

	Sprays			Dusts		
	% Toxicant in Stock Material	Lbs. Toxicant per acre	Lbs. Stock Material per acre	% Toxicant in Stock Material	Lbs. Toxicant per acre	Lbs. Stock Material per acre
Chlordane	50% wettable	1.5-2.0	3-4	5%	1.5-2.0	30-40
Chlorinated camphene	33 1/3% wettable	3.5-4.5	10.5-13.5	10%	3.5-4.5	35-45
Benzene hexachloride (gamma isomer)	6%	0.4-0.5	7-8	1%	0.4-0.5	40-50
	wettable			0.6%	0.4-0.5	70-80

of gallons and the number of nozzles may be adjusted to any given situation so long as uniform coverage is obtained and so long as the sprayer moves no faster than 2 miles per hour. Where hand sprayers are used it will usually be necessary to increase the dosage per acre in order to insure good results.

At the present time these materials can be recommended for use with either wettable or dusting sulfur. The possibilities for using them in other mixtures is being determined. None can be used with lime-sulfur and benzene hexachloride should never

fruit prior to September 1. In its crude form it may impart an undesirable flavor to fruit when used either as a dust or as a spray. This fact was first noted in 1946 when trees were sprayed with benzene hexachloride in oil. In 1947, there was an undesirable taste in early oranges in some of the groves dusted or sprayed in July and August. There had been no taste noted in fruit treated after September 1. Until this phenomenon is better understood, benzene hexachloride will not be recommended for use on citrus trees bearing fruit until after September 1.

Some growers have believed that sulfur



acted as a repellant to grasshoppers. One experiment, performed in triplicate, was made where trees were dusted with sulfur, sprayed with wettable sulfur, and sprayed with lime-sulfur. There were as many grasshoppers on the treated as on the untreated trees during the following days. Casual observations on groves sprayed with sulfur showed no decrease in the grasshopper population. It was therefore concluded that sulfur on citrus has little or no repellency to the American or bird grasshopper under Florida conditions.

#### CULTURAL PRACTICES

Many divergent opinions have been advanced as to the effect of discing or chopping on grasshopper infestations in groves. Enough general observations were made during the 1947 season to determine these effects with some degree of reliability. In general, grasshoppers were found in groves where the cover crop was composed of some type of grass. This grass was usually of the crab grass group. Apparently this type of sod offered a place which was satisfactory for oviposition and also a good food source for growing nymphs. Observations indicated that chopping or discing could be either detrimental or beneficial according to the timing of the operation and the age of the grasshoppers at the time. Thus, chopping or discing the cover crop should be

avoided at a time when most of the grasshoppers are present as large nymphs. At this time since the nymphs cannot fly, they will migrate immediately to the trees and unless insecticide is applied, they may do serious damage.

As noted in the introductory paragraphs, the second generation of the bird grasshopper hatched mainly during the second and third weeks of August. By August 25 the bulk of the hatch had been completed. Two groves, both heavily infested, were selected as places to study the effect of discing on newly hatched nymphs. One grove was composed of 2 and 3 year old orange trees and the other of 10 year old Valencias on sour orange root stock. On August 18 half of each grove was disced in both directions. Results were checked by counting the colonies of newly hatched nymphs. Table III shows the results. On August 22 the number of colonies were counted in 10 checks or squares. A check or square constituted an area with 4 adjacent trees as corners. Three days after discing there was a reduction in 1 grove, but none in the other. The discing had not been sufficient to chop up and kill the cover crop which was present. Therefore on August 25 the areas were rediscd and this time one discing was on the diagonal. Two days later nymph colonies were again counted and this time there was a significant reduction in

TABLE III.  
EFFECTS OF DISCING ON GRASSHOPPER POPULATION

	Date	3 Year Old Trees		10 Year Old Trees	
		Chopped	Disced	Chopped	Disced
Three days after discing (Colonies per square)	8/22/47	7.4	7.6	6.9	2.1
Three days after second discing (Colonies per square)	8/28/47	4.6	0.3	8.6	0.1
Grasshopper nymphs per 100 sweeps	9/15/47	60	4	240	11

both groves. On September 15, a check was again made on the populations in these groves. This time the number of nymphs taken per one hundred sweeps with a standard insect net was taken as the criterion of infestation. As noted in Table II, there was at least a 90 percent reduction in both groves. In another grove which was disced clean about September 10, sweeps were made on September 15 and there were 56 nymphs per 100 sweeps in the chopped as compared with only 6 in the disced area. Thus, it appeared that discing at the end of a hatching period or within 2 weeks thereafter was a means of effectively reducing a potentially serious infestation to one of no economic importance. It should also be noted that these disced areas were not reinfested at a later date.

The explanation for the marked reduction in young nymphal grasshoppers following clean cultivation was probably due to a combination of 2 factors. On one hot afternoon when the air temperature was above 95° F. and the soil surface was 115° F., newly emerged nymphs were thrown on this hot surface and they were able to survive for only a few minutes unless they were able to find an unkilld blade of grass upon which to crawl. The other factor concerned is one of food source. The tiny grasshoppers can only move short distances and if food is not readily available, they can be easily starved to death.

In late October another factor concerning discing became evident. Where almost the entire population was present as adults, it was found that thorough and clean cultivation caused the winged individuals to migrate from the grove into adjacent areas. This was tried with complete success in 2 groves. Although this method may not be completely effective in all circumstances, it offers a means of control in many places at a minimum of trouble and expense. However, the grower should be ready to apply insecticide if for some reason the grasshoppers fail to leave the grove.

#### RECOMMENDATIONS FOR CONTROL.

The following recommendations are based on only 1 season's intensive work and it is possible that some alterations will be necessary in the future. However, it is believed that the following suggestions will afford an effective and economically feasible program.

It is not known at present how the bird grasshopper passes the winter, but it is established with certainty that there will be a hatch in the spring of 1948. In 1947 this occurred in April and May. If groves are maintained in a state of clean cultivation from November until about May 15 to June 1, it is believed that no eggs will be laid there and the only grasshoppers which can attack the grove in June must of necessity come from adjacent fence rows and fields.

If grasshoppers appear in serious proportions in a grove in June, they may be controlled by the use of chlordane (1 1/2-2 lbs. per acre) or chlorinated camphene (3.5-4.5 lbs. per acre) used either as dusts or sprays. Where none develop in June, but where it is anticipated that there will be grasshoppers in the fall, cover crop management should be such as to assure a crop of seed by late August. This involves no chopping after mid-June. Then, if a hatch occurs in the grove in August, there will be no objection to discing in the cover crop within 2 weeks after the hatch has occurred and thus obtain control. If, in spite of these practices, there are infestations later in the fall, they may be controlled by the use of the 2 materials mentioned above or by benzene hexachloride (0.4-0.5 lb. gamma isomer per acre) either as a spray or dust. If the bulk of the population is in the adult stage, it may be forced out of the grove by thorough discing after mid-October. Discing or chopping when hoppers are about half grown should be avoided as they will not be killed by the operation, and since they cannot fly, they will move onto the trees where they may do excessive damage.

Groves should always be prepared for

dusting or spraying by first chopping the cover crop. This resulted in much better control than where cover crops were standing at the time of application.

#### SUMMARY

An account of the 1947 grasshopper problem on Florida citrus is presented. There were 2 generations which did damage particularly in June and early July and again in September and October. Experiments concerning the use of benzene hexachloride, chlordane, thiophos 3422 and chlorinated camphene for grasshopper control are described. The effects of cultural practices

and the possibilities of control by judicious cultivation and cover crop management is discussed. Recommendations for control are outlined.

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## NEW INSECTICIDES AND THEIR APPLICATION ON CITRUS

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During the past four years a number of organic compounds have been developed for use as insecticides. Some of these are already in use and others are still in the experimental stage. When a new insecticide is to be tested, there are a number of factors to be considered and two or three years of experimental work is frequently required before the material can be recommended for general use. Some of the important questions to be answered are:

1. Toxicity of material to various species of insects and mites?
2. Toxicity, if any, to the tree?
3. Minimum concentration which will give results?
4. Compatibility with other materials in combination sprays?
5. Effect on beneficial insect population?

Until the research workers have had time to obtain at least preliminary answers to

the above questions, it is not advisable to treat large acreages with any new insecticides.

Some of the new insecticides may have a limited but definite use in combating insects infesting citrus groves. Until recently there was no insecticidal spray or dust that could be used economically for the control of grasshoppers, plant bugs, ants and shot-hole borers. Now there are several materials which may be used effectively for the control of those insects. Fortunately, the above mentioned insects are not of major importance over a wide area, but any one of the above named group can be of major importance in one or more groves during certain years, and it is at least gratifying to know that there are materials which can be recommended for their control. One or two of the newer compounds may eventually replace some of the insecticides now in use, but only extensive experimental work plus commercial trials can determine their real value.

At the present time the Citrus Experiment Station is working with a number of the newer insecticides but it will take time

before proper recommendations can be made for each of them. In this paper the materials and the results obtained with them are discussed very briefly because a full discussion of any one of them would require the full period.

O,O-diethyl - O-p-nitrophenyl thiophosphate commonly called Thiophos 3422 or Parathion is one of the newer materials that show promise for the control of a wide range of insects infesting citrus trees. This material should not be used generally until it has been tested thoroughly since, according to the manufacturer, 3422 is quite poisonous in the concentrated form and it remains to be seen how toxic it is to human beings in the dilute form. However, there are a number of insecticides now in general use which are poisonous in the concentrated form but not particularly harmful in dilute sprays or dusts and it is hoped that the same will be true of this material.

According to the manufacturer 3422 can not be used satisfactorily in strongly alkaline solutions which limits its use in some combination sprays and much remains to be done in determining the materials it is compatible with and the dilutions needed to kill the various insects to which it is most toxic. Results obtained to date indicate that the toxicity of 3422 to insects is immediate and that it does not seem to have much residual effect.

Preliminary experiments with 3422 indicate that it is effective in killing scale insects. Where one-half pound of the active ingredient per 100 gallons of water was used, purple scale populations were reduced on an average of 81 percent as compared to an increase of 15 percent in untreated plots. Florida red scales were reduced to an average of 70 percent as compared with an increase of 9 percent in the check. Citrus mealybugs, on oranges, were reduced 65 percent while they increased 27 percent in the check. Rust mite populations were reduced to a very low level, no mites being observed 20 days after an application of 3422 in two different groves while checks

showed a 30 percent infestation. A citrus aphid infestation was reduced 99 percent with only a few living aphids being observed in tightly curled leaves.

Since 3422 kills scales and mites it becomes a potentially important insecticide to citrus growers. Extensive testing will be carried out during the next year to determine the advantages and disadvantages of this material.

Di (4-chlorophenoxy) methane, known as K-1875 is one of the newer organic compounds which looks very promising for the control of purple mites. In 1946 Jeppson (3), in California, reported that concentrations of one pound per 100 gallons of spray or 4 percent or more of the active ingredient in dusts gave satisfactory control in preliminary field tests. Results of preliminary field experiments at the Citrus Station indicate that 0.8 to 1.0 pound of the active ingredient per 100 gallons of spray was as effective as DN Dry Mix (40 percent dinitro-o-cyclohexyl phenol) at 2/3 pound per 100 gallons. Where thorough coverage was obtained no living purple mites were observed for at least 12 weeks after single application of K-1875 at either 0.8 or 1.00 pound per 100 gallons. This material is one of the few newer organic compounds which is effective in alkaline solutions, consequently it was combined experimentally with a number of the combination sprays commonly used on citrus. It was found to be effective combined with the following: (1) Lime-sulfur; (2) lime-sulfur and wettable sulfur; (3) lime-sulfur, zinc sulfate and wettable sulfur; (4) zinc sulfate, hydrated lime and wettable sulfur; (5) zinc sulfate, borax, hydrated lime and wettable sulfur; and (6) zinc sulfate, neutral copper, hydrated lime and wettable sulfur.

Young citrus foliage appeared to be more tolerant to K-1875 than to DN but more tests will be necessary before definite conclusions can be drawn. Experimental work is being continued with this material in both sprays and dusts.

Diphenyl trichlorethane or DDT. The

use of DDT on citrus in Florida will probably be limited because of the toxic effect on beneficial insects. Griffiths and Thompson (3), 1947, reported increases of Florida red scales following 1 to 2 applications of DDT combined with either sulphur or an oil emulsion. It was concluded that the increase of red scales was a result of practically eliminating the Florida red scale parasite: (*Pseudhomalopoda prima* (Gir) and *Prospaltella aurantii* How.) and the twice stabbed ladybeetle. Where DDT had been applied combined with an oil emulsion for two consecutive years there was an average of 200 red scales per leaf as compared to 1 scale per leaf where the DDT had been omitted in the oil spray. No parasites were observed in scales where the DDT had been used while there were 35 parasitized scales to every 100 living scales where oil alone was used. Citrus mealybugs and purple mites also increased following DDT sprays.

Osburn (4), 1945, reported satisfactory control of the little fire ant (*Wasmannia auropunctata* (Roger) when he sprayed the trunks and main limbs with a DDT-fuel oil emulsion.

The use of DDT for the control of shot-hole borers in citrus was reported by Thompson (5), 1945. The entrance of the beetle into the trunks of the trees was checked by spraying the trunks with DDT at the concentration of one ounce of DDT in 1 gallon of water. Dead beetles were found at the base of treated trees when the last inspection was made two weeks after treatment.

Benzene hexachloride or BHC has been found to be effective in controlling grasshoppers, planthugs, citrus aphids and to some extent ants, but it was not effective where applied for the control of purple mites.

BHC should not be used in sprays or dusts containing hydrated lime but it can be combined with pyrophyllite, clays, talcs and sulfur. BHC has a heavy musty odor which may be detected in the grove several

days after an application. At present it is not recommended that BHC be sprayed or dusted on trees from the time the fruit has set until September 1 since in some instances where trees were dusted or sprayed during the summer an "off-taste" was detected in some of the oranges when they ripened. The taste was more pronounced when oil had been combined with BHC in the spray. No bad flavor has been detected when BHC was applied as a dust or spray after September 1st. It should never be combined with an oil emulsion if the spray is to be applied on citrus trees carrying fruit. The taste of BHC was very noticeable in oranges six months after an application of BHC-oil emulsion spray.

BHC contains several isomers but the gamma isomer has been found to be the most potent as an insecticide. Growers should become familiar with the term gamma isomer because the insecticidal potency of BHC is reported as the percentage of the gamma isomer in the material. For instance, a 50 percent wettable BHC material containing 10 percent gamma isomer is more potent than a 50 percent wettable material containing 6 percent of the gamma isomer.

The most extensive use of BHC in citrus groves has been for the control of grasshoppers. Griffiths et al. (1947) found that BHC dust containing 1 percent of the gamma isomer and applied at the rate of 45 pounds per acre was effective for grasshopper control. The dust should be applied uniformly on the cover crop and portions of the trees that are infested. Fifty percent BHC wettable material containing 6 percent gamma isomer was effective when used at 1.5 pounds per 100 gallons and applied at the rate of 500 gallons per acre.

Satisfactory control of the citron plant bug infesting oranges was obtained with a spray containing two pounds of a 6 percent gamma isomer wettable BHC per 100 gallons of water. It is possible that a more dilute spray may be effective but until more tests are made, it is recommended that the above dilution be used. A dust containing

1 percent of the gamma isomer was also effective.

Citrus aphids were controlled with a spray containing 2 pounds of a 6 percent gamma isomer in 100 gallons of water. Equal results were obtained when BHC was combined in a spray with a neutral copper and wettable sulfur. Although no tests for residue were made, aphids did not reinfest the portion of the grove where BHC was applied as soon as they did where a rather volatile material was used. A very thorough coverage of infested leaves is necessary for aphid control when BHC is used. In one grove where some of the leaves had been curled by the aphids before the spray was applied, there was a very low percentage of the aphids killed in curled leaves which emphasizes the need for thorough coverage.

Purple mites were resistant to the toxic effect of BHC. Within a few days after the spray, mites were as numerous in the BHC treated plots as in the untreated ones.

Certain species of ants found in groves were killed by BHC dust but where ant hills were treated with 1 percent BHC dust, some ants were killed but in some cases the whole colony was not killed and it became active again.

Chlordane is a chlorinated hydrocarbon which will probably be used for the control of several species of insects. It is formulated in stable emulsions, wettable powders and in dusts. Alkaline materials should not be used as carriers for chlordane because they will reduce its toxicity.

Chlordane has been tested most extensively in Florida for the control of grasshoppers. Griffiths et al. (2), 1947, reported satisfactory control with a 5 percent dust applied at the rate of 30-40 pounds per acre in groves and 20 to 30 pounds in open fields or 1 to 2 year old groves. Control was also obtained with a 50 percent wettable material used at a concentration of .6 pound per 100 gallons of water and applied at the rate of 500 gallons per acre in the grove. In

open fields or in young groves it is recommended that the dilution be increased to 1.6 pounds per 100 gallons and applied at the rate of 125 gallons per acre.

The citron plant bug, *Leptoglossus gonagra*, which sometimes attacks citrus was controlled with the same dosage of chlordane as was used for grasshopper control.

Until recently it has been difficult to control ants which nest at the base of a tree. A 2 1/2 percent chlordane dust has resulted in 90 to 95 percent control of the common species of ants found in groves in the central part of the state; however, when a 5 percent dust was used, all treated colonies were killed out or at least there was no evidence that the colonies became active again. A dust containing 2 1/2 percent chlordane and 10 percent DDT has also resulted in a 100 percent control of ant colonies. The best method of killing out a colony of ants around the base of a tree is to mix a small amount of chlordane dust with the top inch of soil where the ants are working and then sprinkle an additional amount over the top of the soil and around the base of the tree. Where the ant hills are out in the open, a small amount of dust sprinkled in the crater shaped entrance of the hill is sufficient. Injury by ants to young trees was reduced during the winter by sprinkling some chlordane - DDT dust around the base of the tree at the time the tree was banked. In some cases the ants made a nest near the top of the bank and in such cases the dust was placed around the trunks of the tree about one inch below the top of the bank. The leaf eating or agricultural ants can be controlled by sprinkling the chlordane dust over the whole surface around the entrance of the nest.

Chlorinated camphene is another of the new chlorinated hydrocarbons. It is being sold as a dust, a wettable powder and as an emulsified material. Tests for its usefulness on citrus have been limited to the control of grasshoppers and leaf footed plant bugs. Griffiths et al. (1947) reported

that it gave satisfactory control of the bird grasshopper at 35 to 45 pounds of a 10 percent dust per acre, or when used as a spray at 3.5 to 4.5 pounds of the active ingredient per acre. Only preliminary work has been performed on the leaf footed plant bug but a 20 percent dust at 25 pounds per acre showed favorable results.

Hexaethyl tetraphosphate or HETP has been tested for the control of citrus aphids and purple mites. HETP is very volatile and should be used as soon as it is mixed as a dilute spray. It has no residual effect as a spray and should never be combined in sprays containing lime. Precautions should be taken to prevent the concentrated material from coming in contact with the skin.

In experimental tests HETP (100% active ingredient) used at 1-1600, reduced citrus aphids populations 93 to 96 percent where the leaves were not curled. Where it was used in a commercial grove, a medium infestation of citrus aphids was reduced to a very low level.

Where HETP was applied at a concen-

tration of 1-1600 for the control of purple mites, a high percentage of the active mites were killed but, within a week after the application, 9 percent of the leaves were infested with young mites as compared to no mites where a more effective material was used. A month following the application there was no difference in the populations in the treated and untreated plots.

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## COUNT ODETTE PHILLIPPI, - A CORRECTION TO FLORIDA'S CITRUS HISTORY

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Terra Ceia

All the accounts of the introduction of grapefruit into Florida with which the writer is familiar recount that the man primarily responsible was "Don Phillippi, a Spanish Nobleman." No account of his antecedents or how he came to choose the region of Safety Harbor on old Tampa Bay have appeared in any of the accounts that have come to the writer's attention. It came therefore as a surprise, and a distinct shock, to read an authoritative account of this man's career in a newspaper article and to learn that he was no Spaniard but a French-

man and one of a famous family with an important place in French history.

Col. D. B. McKay has been running a series of most interesting articles in the Sunday edition of the Tampa Tribune, articles dealing with the early history of Tampa and the surrounding territory. A newspaper man of long experience, several times Mayor of Tampa, and a student of history, his articles are on a plane far above the common run of reminiscent anecdotes. In the issue of Dec. 29, 1946, he gives a detailed account of this famous Frenchman to whom Florida is so much indebted. His career is so eventful, and truly romantic as to furnish the theme for a historical novel

that in the proper hands might easily become one of America's "best sellers."

Col. McKay reveals that Count Odette Phillippi was a friend and associate of Napoleon Bonaparte, also was a great nephew of King Louis XVI of France. When they were schoolmates together, Napoleon specialized in military strategy, while Phillippi took up the study of medicine and surgery. When Napoleon came to power as Emperor he appointed Phillippi as Chief Surgeon of the French Navy. He won laurels in this position, his Admiral making a commendatory report on his services in a naval battle occurring in August, 1804, as a result of which he won a special decoration. Not long after, however, Oct. 21, 1804, occurred the great naval battle of Trafalgar, in which the British fleet under the famous Lord Nelson almost destroyed the French fleet. Among the French prisoners taken was Count Phillippi. Along with the other prisoners of war he was sent to the Bahama Islands. There his skill as a physician was so helpful to the British in their administration of the colony that within two years he was given his freedom, under a pledge not to return to France.

He first went to Charleston where he married a beautiful French girl. They lived on an extensive plantation near Charleston until her death in 1814. Her grave in Charleston is marked by a beautiful monument in the Catholic Cemetery.

He remembered the citrus fruits he had learned to like in the Bahamas and he soon outfitted a sloop determined to seek a place where he could grow such fruits and recoup his fortunes brought low by some heavy losses due to endorsing the note of a friend.

He sailed to the Bahama Islands to secure plants. Not content with just securing seed or small seedlings he had bearing citrus trees dug up for transfer to the land of his dreams—Florida. He first attempted a settlement in the Indian River section on the East Coast. Indians were at that time generally friendly but attacks were of occasional

occurrence. Through the warning of a friendly Indian, he barely escaped when a marauding band burned and destroyed his buildings and plantings, as he sailed away in his sloop, named for the famous Marshall Ney. Before this tragic end of his first Florida venture he had made several trips to Key West and Havana and on one of these trips he was captured by a pirate by the name of Gomez. He soon cured some of the pirate crew that were ill of fever. So grateful were the pirates that they not only released his ship but placed aboard the Ney a large chest filled with treasure taken as plunder from other vessels. Still more important at the time, the pirate captain gave him a letter that would secure him immunity from future pirate attacks. This letter came in handy on a later occasion.

When Phillippi told the pirates of the ill fortune that had befallen him in the destruction of his East Coast plantation, one of the pirates comforted him by the assurance that it might all prove good fortune—that a better land lay on the western side of Florida. The pirate produced a map of what we now know as Tampa Bay and especially recommended the area on Old Tampa Bay near the present site of Safety Harbor. Count Phillippi was so impressed that he determined to take the pirate's advice. He arrived in the Bay in the spring of 1823, and found it all that the pirate chief had claimed. We of today in Florida can only be too grateful that a man trained in scientific methods was the one to introduce citrus and especially grapefruit into the West Coast of Florida. He was careful in his selection of varieties and his grove, variously reported as 10 to 100 acres, was a marked improvement over his East Coast pioneer planting. Evidence of his care in selection is the accepted fact that one of the first generation seedlings of his grapefruit introduction became the parent tree of the Duncan grapefruit, the variety that for over fifty years has been the accepted standard of excellence among Florida grapefruit varieties.



The amazing thing in this revelation regarding the career of Count Phillippi is that scores of residents of Tampa and in Pinellas County must have known for a long time that our citrus histories were all wrong. Col. McKay cites a half dozen Tampa families who are descendents of the famous Count. One of them, Mrs. Nell Verri Clark, possesses a magnificent necklace and locket ornamented with the French fleur-de-lis, indicating that Gomez had secured it as loot from a captured French vessel. The chest with most of the treasure was lost in the great hurricane of 1848 which inundated the Phillippi property, forcing all residents to flee inland. The Count was no quitter, however, but promptly set about rehabilitating his home and grove, locating however on higher land. He distributed seed and seedlings to his neighbors throughout the Pinellas Peninsula and helped greatly in familiarizing growers with grapefruit and its culture. The only places known to the writer which carries the pioneer's name are Phillippi Creek, a few miles south of Sarasota, and Phillippi Hammock near Safety Harbor, the site of his grove development. Upon his death in 1869 he was buried near his last earthly home, his grave marked with a simple tombstone bearing the epitaph:

"Dr. Odette Phillippi  
Born Lyons, France  
1785—1869"

In 1940 the Clearwater Chapter of the D. A. R. erected a bronze tablet at the grave inscribed as follows:

"Phillippi Hammock  
was homesteaded on this site by Dr. Odette  
Phillippi, Pioneer  
where citrus was introduced by him in 1846  
Born Lyons, France, 1785  
Died at his homestead in Florida 1869  
Dedicated by Clearwater Chapter, D. A. R.  
1940"

The date 1846 is evidently an error as Col. McKay agrees. The Count's grove had probably been in production for 20 years or more at this time.

The writer is making this contribution to the Proceedings of the Florida State Horticultural Society partly to put himself right on this important phase of Florida's Citrus history. A few years ago the writer contributed to the program of the Florida Academy of Science a brief paper entitled "Some Aspects of the History of Citrus in Florida." This was published in the Quarterly Journal of the Florida Academy of Science, Volume 8, Number 1, March, 1945.

In this sketch touching only the high lights of Florida's Citrus development the writer, following such eminent authorities as H. H. Hume and H. J. Webber, referred to "Don Phillippi a Spanish Nobleman" and gave the date of his landing on the shores of Tampa Bay as 1809, as recorded by earlier authorities. Having lived a good part of thirty-five years just across Tampa Bay from Pinellas Peninsula the author feels chagrined and more or less ashamed not to have learned the actual facts in regard to this famous Frenchman and to have avoided the errors of previous writers. The date 1809 is clearly in error. At that time Count Phillippi was living with his wife and four daughters on his large plantation near Charleston. It was not until 1823 that he arrived in Tampa Bay, following his having been driven off his East Coast plantation by hostile savages.

The author is glad to make this belated correction and to pay tribute to Col. D. B. McKay, distinguished citizen of Tampa, who has made it possible to set our records straight on this important event in our citrus history and its effect on the development of the West Coast of Florida.

# SPRAYING GRAPES FOR DISEASE CONTROL IN FLORIDA—1945-1947

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At Whitney, Florida, 4 miles west of Leesburg, is located a small vineyard of about 500 bunch grapes, variety Extra (Florida Beacon), which has served since 1942 as a testing ground for the development of a spraying program for grape disease control and for materials which might possess fungicidal value and at the same time not discolor fruit.

Three fungus diseases make spraying of grapes imperative in Florida, *Guignardia bidwellii* (Ell.) V. & R., which causes black rot, *Melanconium fuligineum* (Scrib. & Vial.) Cav., which causes bitter rot, and *Glomerella cingulata* (Ston.) Spaul. & Schrenk, which causes ripe rot. Loucks (1) worked out a spray program at Whitney for the Florida grape grower and showed that the most important sprays were those applied during blooming and fruit setting. For average years, 8 or 9 sprays are necessary, applied at about 10 days intervals. Loucks recommends 4-4-50 bordeaux except just prior to fruit ripening, when copper acetate is substituted in 2 sprayings. When the fruit is picked, the last spraying can be bordeaux mixture. The reason for the substitution is that bordeaux leaves a deposit on fruit and detracts from its sales value. Loucks states that he found bitter rot and ripe rot more difficult to control than black rot and thought that this was perhaps due to the more frequent rains during the ripening period when the first 2 rots occur, but allowed the possibility that copper acetate was less effective against these diseases than bordeaux.

From 1945 to the present we have followed Loucks' spray program with bordeaux but have tried other materials as well to find a better fungicide, always keeping in mind that no fungicide must discolor the fruit in such a way as to reduce its attractiveness. For 2 years, 1945 and 1946, we used bordeaux (4-4-50) as our standard, and we discovered that while it is a good fungicide it also causes a stunting of the plant, presumably through hardening of the epidemis and in the absence of any fungus can reduce the yield. We have had 2 years, again 1945 and 1946, when grape diseases were practically negligible because we had little or no rain, but in 1947 we had an outbreak of black, bitter, and ripe rots, so our studies are fairly well balanced. We have used the dithane-zinc-lime spray (2 qt.-250 gm.-192 gm. per 100 gal.) for 3 years and we like it. Vines sprayed with this material are glossier in appearance, seem to possess more luxuriant foliage, and bear better than when sprayed with other chemicals (Table 1). Whether or not the presence of the zinc in the spray has a nutritional effect on the plant we do not know.

The fungicides we have tried are listed in table 1; you will note that we eliminate materials as we go along for one reason or another. We dropped Wettable Spergon (2 lb./100 gal.) because it discolored the fruit, likewise Fermate (2 lb. /100 gal.). Copper Compound A (4 lb. /100 gal.) produced burning of the foliage and lowered yields which might possibly have been corrected by the addition of lime but we discontinued it so that other materials might be tried. After 2 years trials we even discontinued bordeaux, and now dithane-zinc-lime is our standard. Carbide & Carbon Chemicals Corporation's 2 ma-

terials, No. 341A (2 1/2 lb. /100 gal.) and No. 169 (4 lb. /100 gal.) are promising but the yellow No. 169 does discolor the fruit. This year, for the first time, we have applied fungicides (listed for 1947 in table 1) throughout the summer, at 2 week intervals, and find that plots sprayed with No. 169 look best, even better than the dithane-zinc-lime which is second. Conceivably, we might use dithane-zinc-lime until after harvest, then switch to No. 169. Post-harvesting spraying has not been recommended, but it is a well known fact that next year's crop is somewhat dependent on how long leaves stay on the vines the previous year.

In summation, we recommend that bunch grapes in Florida be sprayed with dithane-zinc-lime instead of with bordeaux; the dithane spray gives good disease control, high yields, and may be applied on almost ripe or ripe fruit without fear of discoloring the grapes. Carbide & Carbon Chemical Corporation's No. 341 A also shows promise of replacing bordeaux as a spray for grapes in Florida.

#### LITERATURE CITED

1. LOUCKS, K. W. Spraying experiments for the control of certain grape diseases. Fla. Agr. Exp. Sta. Bul. 294: 1-16. 1936.

TABLE 1—SPRAYING GRAPES (*VITIS LABRUSCA*) FOR DISEASE CONTROL, WHITNEY, FLORIDA; 1945 TO 1947

Fungicide	Total Yield per 100 plants (lb.)	Percent Culls	Total Yields Marketable Fruit(Lb.)	Sale Value at \$0.20 per Lb.	Sale Value Per Acre
1945					
FERMATE	251	11	223	\$ 44.60	\$388
SPERGON	272	13	237	47.40	412
BORDEAUX	277	4	266	53.20	462
COPPER A	212	15	180	36.00	313
ZERLATE	278	10	250	50.00	435
DITHANE	345	4	331	66.20	575
UNSPRAYED	270	10	243	48.60	422
1946					
BORDEAUX	718	11	640	\$128.00	\$1113
ZERLATE	689	23	529	105.80	920
C&C's 341	916	17	751	150.20	1306
DITHANE	893	9	808	161.60	1406
UNSPRAYED	749	16	622	124.40	1082
1947					
ZERLATE	892	24	677	\$135.40	\$1178
C&C's 341A	975	15	778	155.60	1353
C&C's 169	741	25	554	110.80	964
DITHANE	1048	14	944	188.80	1642
UNSPRAYED	480	47	252	50.40	438

## VEGETABLE SECTION



# NEW VEGETABLE VARIETIES FOR FLORIDA

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Since the publication of Florida Agricultural Experiment Station Bulletin No. 405 in 1944 and the paper on new varieties by E. C. Minnum published in the 1944 Society Proceedings, many new vegetable varieties, strains and hybrids have been found suitable for use in Florida under various climatic and soil conditions.

It is the purpose of this paper to bring these varieties and strains to the attention of the membership so that by trial plantings, they may benefit directly by adopting varieties better adapted to their individual needs. A suitable variety or hybrid can often give the increase yields that make the difference between profit and loss, can often spell the difference between high quality which is always in demand and the "drug-on-the-market" type of quality which can stand little competition. This extra quality is going to become more important as pre-packaging of vegetables gains in importance, and as the individual grower's identity becomes a part of the pack. Eye appeal may sell the first package, eye appeal plus taste appeal the repeaters.

More attention probably has been given to the producing, testing, and selecting of varieties and hybrids than another phase of vegetable production. The result has been that there are many varieties of most kinds of vegetables, and the production of new vegetable hybrid lines is increasing year by year. Only through the diligent testing of these varieties in many sections of the vegetable growing areas can those best adapted to Florida's varied soil and climatic conditions be found. In spite of the accumula-

tion of much information by numerous workers, the selection of the best variety for a given location remains a serious and difficult problem.

In addition to the importance of quality improvement and increased yields many of the new varieties also add crop insurance through disease resistance. This factor is especially important in the older growing areas where the land has become infected with the many soil inhabiting diseases, such as fusarium wilt, southern blight and pink rot. Varieties resistant to such diseases as potato late blight, which has been so destructive on tomatoes, early blight on tomatoes, frog eye spot on peppers, tip over of eggplant and others too numerous to mention are badly needed. Choosing the right variety from this standpoint is often more important to the grower than other factors, because if old, diseased land is to be planted, the choice of a variety resistant to the disease involved will assure him of a crop while the use of a susceptible variety would more than likely prove a failure.

A clarification of the terms, Variety, Strain, Hybrid and Lines, as used in most publications on vegetables might be of interest. Quoting T. O. Graham in *Vegetable Varieties & Hybrids* "There are basic differences between a variety and a hybrid. In a variety, the seed for the crop is produced through pollination which is not controlled. Trueness to varietal type is maintained by elimination of off types by selection. In a hybrid the seed is produced as a result of controlled pollination." The term strain is applied to a certain selection of a given cross propagated to maintain certain desirable characteristics; a line is usually a single plant selection from a cross from which additional single plant selections may be made or plants having undesirable char-

acteristics eliminated. A given line either soon becomes a strain or variety or is eliminated as undesirable. Hybrid vegetables often produce plants of great vigor and yield capacity, very uniform in size, quality, uniformity of maturity, and resistance to disease.

We can expect to see the use of hybrids increase in vegetable growing as methods of producing seed in quantity are perfected and cost of seed reduced. The hybrid has proven its worth in many kinds of vegetables, and no doubt new ones will be added to the list rapidly and may well add to the confusion already existing until testing has eliminated those unsuited for Florida.

New varieties or varieties listed as promising in the Florida Bulletin 405 found by field trials to be suited for commercial growing in various sections of the state are as follows:

*Tomatoes.*—Many new tomato varieties are in prospect for the near future. Through the regional office U. S. D. A. at Charleston S. C., seed of new varieties of vegetables are collected and sent to collaborators for testing. During the past 2 growing seasons some 70 varieties and strains of tomatoes were tested at the Vegetable Crop Lab., some in regular yield trials, others in preliminary observational trials.

Many of the new varieties in trials hold much promise, both as to adaptability and quality. However, seed is not available commercially, though a few new varieties may make their appearance during the next season. Until such time as yield tests have been concluded on these new varieties and recommendations made, it is advisable for growers to be cautious, making only small trial plantings rather than risking large acreages on an unknown variety.

#### RECOMMENDATIONS FOR THE FLORIDA WEST COAST

Ft. Myers section: Rutgers, which produces a tomato of excellent quality, firm and uniform. The vine is somewhat heavy

and light pruning might be indicated to produce better fruit set. Grothens Globe, earlier than Rutgers, but produces better yields of smaller sizes and poorer quality. These conditions may be due to cultural practices. Valiant looks promising in this area for early plantings.

Manatee-Ruskin area: For fall, Gothen Globe, Valiant and Stokesdale. Grothen Globe is the accepted standard in this area. Valiant is a heavy producer but, like Stokesdale, may produce small fruit. It is the earliest of the varieties tested. For soils badly infected with Fusarium wilt, a new variety U. S. 24 is suggested. U. S. 24 produces uniform fruit of better quality than Pan America. One or more varieties that are extremely resistant to Fusarium wilt and some of the common leaf spot diseases (not Late Blight) is expected to be released from the Vegetable Crops Lab. within a short time.

In the spring for the Manatee-Ruskin area, Rutgers and Grothen's Globe are still favorites. The new variety U. S. 24 is suggested for trial on wilt infested soils. Valiant does not produce sufficient leaf cover to protect fruit during late spring; it sun scalds even when staked.

For south Florida and the east coast section no change in recommendations is made in this paper. A paper to follow will discuss tomatoes for the East Coast section.

*Pepper.*—No new varieties have appeared; some work along hybrid lines is being undertaken by some of the seed growers, and one or more may appear in the market soon. Until such time as these have been tested, old line varieties are recommended according to the demand of the market.

*Onions.*—A new variety, Excel, a yellow Bermuda type, very uniform in size and shape, 10 days to 2 weeks earlier than other Bermuda types, is suggested for central and north Florida.

Texas Grano is more uniform and earlier than Grano, and is recommended.

*Lettuce, Iceburg Type.*—For early and late plantings the new variety Great Lakes is recommended. It is of uniform, medium size, resistant to bolting and tip burn.

For Midseason, Imperial 44 and 847 are still recommended.

*Eggplant.*—No new varieties have made their appearance. However, inquiries to Dr. Phares Decker of the Experiment Station at Gainesville indicate promise of a new eggplant variety soon, that will be highly resistant to "tip over."

*Cantaloupe.*—A trial planting of cantaloupe at the Vegetable Crops Laboratory last spring indicated that this crop has possibilities in the area extending as far south as Ft. Myers. New disease resistant varieties and new organic fungicides and insecticides which are safe to use on cantaloupe add to the crop's possibilities.

Varieties found promising were Smith's Perfect, Texas No. 1, and Burrell's No. 4. Smith's Perfect, though rather late maturing, proved most resistant to both Powdery and Downy Mildew.

*Pole Beans.*—A new variety, Blue Lake, has been grown very successfully in West Florida. For the Manatee-Ruskin area McCaslan, U. S. No. 191 and U. S. No. 3 are recommended.

*Cucumbers.*—Tests during the past two seasons indicate that several new Downy Mildew resistant varieties produced at the South Carolina Experiment Station by Dr. W. C. Barnes and co-workers hold much promise. In yield tests during the past 2 seasons these lines yielded significantly better than any of the accepted commercial varieties in the planting. As a matter of fact, some of the commercial varieties died

without producing a single marketable fruit, while others produced only a few.

The variety Puerto Rico 39 produced more fruit than the S. Carolina strains but the fruits were shorter and not as good in quality.

Burpee Hybrid, maturing later than either the P. R. 39 or the South Carolina strains produced the highest yield. This variety produces beautiful long medium dark green fruits which like the P. R. 39 have a tendency to "flecking" (a tiny white specking in the skin).

One of the S. Carolina strains will be available probably for spring planting in Florida and will be known as "Palmetto." It is highly recommended. Of the regular commercial varieties, the recommendation remains the same, except that the variety Marketer has been accepted by most growers in the Wauchula, Manatee, Ruskin area and is planted extensively.

*Sweet Corn.*—For the Manatee-Ruskin area, recommendations would include Ioana, Golden Cross Bantam and Ill. Golden No. 10. Of the newer hybrids tested, Seneca Chief, Erie, Oto and Golden Grain produce high yields of excellent quality. Seneca Chief produces a medium sized ear well filled to tip, of excellent flavor, a week to 10 days earlier than Ioana. Golden Grain has same maturity time as Golden Cross Bantam, produces a larger ear which is very uniform.

In the Gainesville area Golden Security, Tri State, Oto, Erie, Victory, Golden, Ioana, Seneca Chief and Ill. Golden produced the best yields in the order given. Trial plantings of these varieties are recommended before large acreages are planted to determine variety best suited to growers particular conditions.



# CONSUMER PACKAGING OF VEGETABLES

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What is meant by consumer packaging or prepackaging, whichever you may choose to call this new industry? Retailers have been weighing, bagging, or otherwise packaging vegetables ever since the first markets were established. The "pre" was attached to packaging to designate the new merchandising method in which the actual packaging operation was performed before the produce entered the retail store. Consumer packaging is another term referring to the preparation of a unit which has been previously wrapped in convenient form for the consumer to select and carry home with a minimum amount of handling. Prepackaging or consumer packaging also indicates that the produce in the package has been trimmed, washed, or otherwise prepared for cooking or eating.

The beginning of consumer packaging is very hard to trace. Potatoes and onions have been sold in various small containers for many years. The R. T. Brown Cannery at Springfield, Mass., using the name of Farmer Brown, made one of the first attempts to market consumer units of spinach wrapped in transparent film. At the present time, Farmer Brown is packaging eight or ten cars of mixed vegetables per week.

In Los Angeles, Cal., the Sunny Sally vegetable growers started packaging spinach in 1939, and in 1946 sold between 5 and 10 million consumer units in cellulose acetate bags.

Since 1945 the Ohio State Agricultural Experiment Station in cooperation with the Great Atlantic and Pacific Tea Company has been conducting the much publicized Columbus experiment. The vegetables are

all packaged in the A & P Company warehouse in Columbus and sold in ten supermarkets equipped with refrigerated display cases. The emphasis in this study has been placed on consumer acceptance and the reduction of spoilage and waste.

During the last few years the consumer packaging of fresh produce has attracted widespread interest. All types of trade and scientific journals, as well as newspapers, are publishing articles on the subject. Pre-Pack-Age, a new monthly trade journal devoted to modern methods of packaging and merchandising fresh foods, started publication in September of this year.

There are several reasons for this increasing public interest. Leaders in the fresh produce industry estimate that 25 to 35 percent of all the edible produce grown in this country is wasted somewhere along the line between the farm and the consumer. Our wasteful handling methods are particularly bad in the present period of world food shortages and high food costs which are partly attributable to the high cost of distribution. The housewife of today has been educated in terms of food quality, grades, balanced diets, including fresh vegetables and the methods for preparing the most tasteful and nutritious meals. She has also learned how to avoid the long hours of toil in the kitchen each day which were demanded by the old methods of food preparation. Thus, we find an increasing demand for fresh produce prepared in advance for cooking or eating.

Many problems have arisen in connection with this new method of merchandising and research projects are being initiated by government agencies and many industries in an attempt to find the answers. For instance, authorities differ as to whether the packaging should be done at the shipping point or at the terminal market. Since Con-

gress passed the Research and Marketing Act in 1946 (Public Law 733) new emphasis has been placed on marketing research by Federal and State agencies. Consumer packaging studies already being conducted by the Florida Agricultural Experiment Station are being expanded under this new law.

Before prepackaging can be successful there are a considerable number of basic laboratory tests which must be made with the great variety of packaging materials on the market. For example, 41 different standard types of cellophane film are being manufactured by a single company. In addition to cellophane, the following films have been used for food packages: Pliofilm, Vinylite, cellulose acetate, ethyl cellulose, Vitafilm, and polyethylene.

Rapid progress has recently been made in the manufacture of new plastic, paper, and synthetic rubber films and packages. The raw materials and methods of producing the various films are quite different. An outline of the manufacturing process for cellophane will show not only the composition, but the possible variations in the process which result in very different physical properties of the film.

Cellophane is regenerated cellulose made from cotton, straw or wood. The highest quality cellophane is made from cotton, but the bulk of the supply comes from wood pulp. Pieces of pulp wood are steeped in sodium hydroxide solution, cut into fine pieces, then treated with carbon disulfide to produce cellulose xanthate. This material is mixed with a dilute solution of sodium hydroxide and aged for several days under a high vacuum to remove all air bubbles. This viscose liquid is then ready for making cellophane sheets, viscose rayon thread, or cellulose sponges. In the manufacture of cellophane, the viscose is forced through a long narrow slot which is immersed below the surface of an acid coagulating bath. The resulting film is run through a tank containing a dilute glycerine solution or other softening agents, and then dried. This

film is not moistureproof or heat-sealing. A coating of wax, plasticizer, or resin must be applied in a very thin layer on one or both sides to reduce the moisture-vapor transmission and provide a means for heat-sealing. The common heat-sealing and moistureproofing coatings have poor adhesion to the cellophane in the presence of water. Another treatment, called anchor coating, is necessary when the film is made for packaging wet materials.

Plio film is made by treating rubber with hydrogen chloride to form rubber hydrochloride. Lumarith is cellulose acetate made from wood or cotton cellulose treated with acetic acid and acetic anhydride. Vita-film and Vinylite are polymerized plastic resins. The Vitafilm is polyvinyl chloride and the Vinylite is a copolymer of vinyl chloride and vinyl acetate made from ethylene and acetylene gases derived from coal. Ethyl cellulose is made by treating cellulose with sodium hydroxide and ethyl chloride. Polyethylene consists of long chains of methylene groups formed by polymerizing ethylene gas under high pressure and high temperature.

In addition to the choice of packaging material, the type and size of the packages are also very important. Some vegetables are individually wrapped. A head of lettuce, an ear of corn or a stalk of celery with the tops trimmed may be loosely sealed in cellophane or stretch-wrapped in pliofilm. Stretch-wrapping is a technique whereby the Pliofilm is heated momentarily to a temperature of about 300° F. and the vegetable is pushed into the elastic film and tightly sealed. Bunch wrapping is applicable to such crops as carrots, green onions, asparagus and broccoli. The wrapper is applied directly to a standardized group or weight of vegetables. Transparent bags are used for quite a variety of items such as green beans, spinach, salad mixes, peppers, and shelled peas and lima beans. Certain paper manufacturers are selling paper bags with a transparent film window in the side. Window boxes are made with

a transparent window sealed in the top of the box as is commonly used for tomatoes. Over-wrapped trays or boats are made by wrapping film completely around a cardboard container with 2, 3 or 4 sides. This type of package is suitable for cauliflower, broccoli, green beans, radishes, tomatoes and sweet corn. Fully transparent plastic boxes have recently been placed on the market, but they are rather expensive for use as a vegetable package.

The physical properties of a particular film or type of package will largely govern its use as a packaging material. The degree to which a packaged vegetable is visible has been found important. In past years the housewife used her senses of sight, smell, and feeling in picking out her vegetables from open produce counters. When these vegetables are placed in an entirely closed package, the average buyer wants at least partial visibility. Varying degrees of transparency are inherent properties of the various films. Some are very clear, while others are slightly cloudy or yellow. Some types of films are clear when dry, but turn cloudy or milky white from contact with water on the outside of the package or water vapor on the inside.

The permeability of a film to the respiratory gases is very important in determining the composition of the atmosphere inside the package, which in turn influences the storage life and quality of the vegetable. It should be emphasized that vegetables in consumer packages are still living as contrasted to vegetables that have been killed by blanching, cooking, freezing, or drying. After the vegetable is harvested such metabolic processes as respiration and transpiration continue at a rate controlled by the environment. The ideal handling conditions will slow down these processes as much as possible without causing death and subsequent rapid deterioration. Very little change will take place in the fresh vegetable if it can be held at temperatures just above the freezing point. The loss of carbohydrates and vitamins by enzymatic action

and oxidation will be reduced by low temperatures and a low supply of oxygen in the package. During normal respiration the carbohydrates are united with oxygen and the end products are carbon dioxide and water. If the film is not permeable to the intake of oxygen and release of carbon dioxide, the available oxygen will be used and pressure built up from excess carbon dioxide. The ideal film for most vegetables, according to Plantenius', would be one which maintained an oxygen concentration of 3 to 5 percent within the package. When the oxygen content drops below 3 percent anaerobic respiration occurs with the production of alcohol and bad odors and tastes. An exception was found by Scott', who packaged snap beans and found that atmospheres of .4 and .7 percent oxygen and over 25 percent carbon dioxide produced no deleterious effects in 7 days. Instead, there was less discoloration and loss of Vitamin C in these packages of beans than in the more permeable packages.

According to various authorities, the films with the greatest permeability to respiratory gases are ethyl cellulose, cellulose acetate, non-moistureproof cellophane and unplasticized Pliofilm. When the moisture proof coating is applied to cellophane or a plasticizer added to Pliofilm the gas permeability is greatly reduced. When low permeability films are used, the film manufacturers recommend punching a hole in the package for ventilation. Spoilage losses due to anaerobic respiration have been low in commercial packaging operations because the packaging machine often makes an imperfect heat seal or the film is slightly torn during handling.

Moisture vapor transmission through the package governs the amount of weight loss and wilting of the vegetable. Cellulose acetate and non-moistureproof cellophane allow very rapid loss of moisture. In experiments conducted in the Horticultural laboratories at Gainesville during the past year, the average weight loss of spinach packaged in cellulose acetate was 26% after 8 days at 45° F. During the same time the loss in

non-moistureproof cellophane was 37% and in the check package of cheesecloth the weight loss was 40%. The moisture-proof cellophane and Pliofilm packages lost only 2 and 3% in weight. Small holes in the film for ventilation have very little effect on the amount of moisture lost.

Before a film can be used as a packaging material its sealing properties must be known. The Vitafilm, Vinylite, polyethylene, Pliofilm, and heat-sealing cellophane films can be sealed by hand or automatic machines adjusted to the proper temperature for each film. Cellulose acetate and ethyl cellulose films must be sealed with a special glue or solvent. Some prepackers are closing their packages with staples or scotch tape instead of sealing them.

The flexibility of most films is controlled by the amount and type of plasticizer incorporated in the film. Without a plasticizer many plastics are rigid and brittle. Since Pliofilm is made from rubber it is naturally very flexible except at low temperatures, where a softening agent is necessary. Therefore, films are being produced of variable composition for uses at specified temperatures. The tensile strength of any one film varies with the composition and thickness and the temperature at which it is used.

The gauge or thickness of a film has considerable effect upon its physical properties as well as the area of film per pound. Standard types of non-moistureproof cellophane are made in three gauges of .0008, .0012 and .0016 inches in thickness. When these films are moistureproofed approximately .0001 of an inch is added to each film. The area of one pound of .0008 in. plain cellophane is about 23,400 square inches, while the area of the .0009 inch moistureproof film is reduced to approximately 21,000 square inches per pound.

The question of film cost is often raised in connection with prepackaging. The .0009 inch moisture-proof anchor coated cellophane will be used for an example at the January

1, 1947, price of 57c per pound. In overwrapping an average size cardboard tray about 1600 square inches of cellophane will be required. Thus, about 130 packages could be wrapped from one pound of film measuring 21,000 square inches. The cost per package would be approximately 43 of a cent.

Other film manufacturers produce films that are thinner and thicker than those mentioned above. Pliofilm is produced in very thin stretched or tensilized form at 20 gauge (.00020 in.). The film with .0016 in. thickness has sufficient rigidity for use in window boxes or bags. Transparent boxes are made from cellulose acetate, Vinylite, and other plastics but the percentage of plasticizer is lowered to produce greater rigidity. A gauge of .010 inch is about the lowest limit of thickness if the box is required to withstand any appreciable pressures. Metal reinforcements are used to join the corners and provide additional support for one type of transparent box.

The prevention of micro-organism growth in consumer packaged vegetables is one of the first essentials in maintaining quality. Rapid changes in taste, color, and texture result from the growth of various types of bacteria and molds. Film manufacturers have produced films with various bactericides and fungicides incorporated in the film. Some of these compounds produce bad odors or tastes and therefore cannot be used. The growth of micro-organisms on the Vinylite film itself is controlled by using tricresyl phosphate instead of the more common plasticizer, dioctyl phthalate.

In our laboratory prepackaging trials this year with green beans and spinach the most outstanding packages were made of Vitafilm with 3 percent tri-o-xenyl borate incorporated in the film. The beans and spinach in this film were still in good condition after 12 days at 42° F.

In conclusion, it should be emphasized that if the packaging of fresh vegetables in consumer sized units is to be a success.

a tremendous amount of research is still necessary on all the phases involved from the time the vegetables are grown in the field until they are eaten by the consumer.

<sup>1</sup>PLATENIUS, HANS. *Modern Packaging*, Vol. 20, No. 2, pp. 139-143, 1946.

<sup>2</sup>SCOTT, L. E., *Pre-Pack-Age*, Vol 1, No. 1, pp. 16-18, 1947.

## PREPARATION OF PRODUCE FOR PREPACKAGING

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It is agreed by all that the basic aim of prepackaging is to give the consumer a better product and to procure more favorable economic return for the producer and the retailer.

Under the normal method of handling produce, the inedible portion of vegetables left attached constitutes a large portion of the total shipping weight. Cauliflower represents the extreme case where the curd or edible portion represents only about 40% of the total weight. Fresh corn when husked and trimmed eliminates about 50% of the weight, and even carrot tops account for almost 25% of the normal shipping weight. Aside from the additional transportation costs, there is the added labor cost of removing this inedible portion. Accumulation of these waste materials at one location may lead to profitable by-products, such as animal feeds (1, 2).

Handling produce in the same old way up to the retailer or distributor discarding a third or a half in the garbage can, just doesn't make sense.

But let's see how prepackaging might give a better product if given the proper preparation.

Basic quality is the success of any food product, whether fresh, canned or frozen. Basic quality rests on three factors: (1) variety or type of crop, (2) harvesting at the proper stage of maturity, and (3) retention of the desirable constituents during handling, transportation and marketing.

The variety or type of crop must be selected for packaging. Size and shape vary as to variety, and should be chosen for adaptability for prepackaging. Then too, proper production can add to this phase; for example, experiments have revealed that peas can be increased in yield and yet kept in a fancy grade for a longer period by the liberal use of a high nitrogen fertilizer.

Proper maturity is of prime importance, and even though it is already the subject of numerous regulations; nevertheless, it requires considerable attention.

Our third point, retention of the desirable constituents during handling and transportation, is the point which we want to consider in a little more detail.

As we all know, fruits and vegetables are living tissue which respire, and in doing so, the desirable constituents are altered. The higher the temperature, the faster they respire, and the faster they deteriorate.

Leafy vegetables have high heat values, and must be cooled very rapidly to prevent yellowing. The respiration rate of spinach (3) is a good example of the high respiration rate of leafy vegetables.

The principal changes brought about by respiration are: loss of moisture, sugar, Vitamin C, and the loss of other desirable constituents. Asparagus loses almost 6 times as much sugar at 50° F. as at 32° F. Un-iced kale (4) loses 44% of its ascorbic acid content in 6 days, 3 times greater than at 32° degrees Fahrenheit. Subsequent changes in the substances in the cell wall leaves produce susceptible to decay producing organisms. All of these contribute to the loss of what we call—freshness.

TABLE I.

Temperature Degrees Fahrenheit	Mgr-CO <sub>2</sub> per Kg-Hr.	B. T. U. per ton per day	Estimated Storage Life-Days	Pounds of ice per ton per day
75	275.0	60,500	2	420
50	60	16,500	5 to 6	115
33	15	4,125	10 to 20	29

The object of our cooperative experiments last season with Mr. Dickman of Ruskin, Florida, was to study the possibility of reducing these losses through the use of "Steri-cooling." This method of pre-cooling employs the use of large quantities of ice water flooded over the produce to obtain rapid heat transfer. Our standard commercial unit floods almost 2000 gallons of water per minute. Added to the water is a germicide to aid in control of the rot producing organisms.

Vegetables included in these semi-commercial tests were lettuce, broccoli, cauliflower, corn, tomatoes, string beans and lima beans.

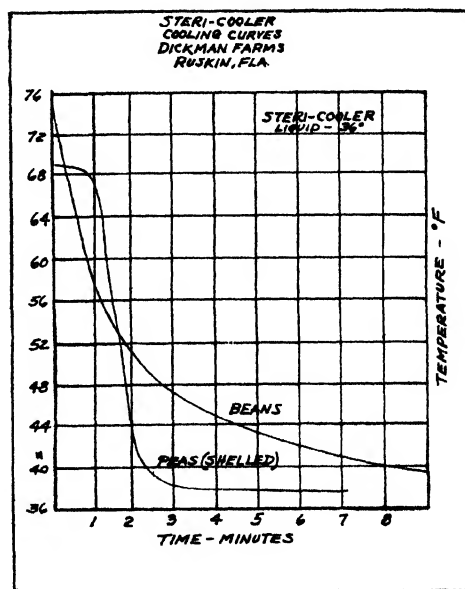
Husked corn was cooled from 86° to a cob temperature of 40° in 24 minutes. Ripe tomatoes were cooled from 80° to 41° in 23 minutes. Other products of less bulk were cooled more quickly as shown on the accompanying graph (Fig. 1). These temperatures were taken internally, and naturally exposed surfaces were somewhat lower.

For optimum cooling, the product should be prepared for prepackaging before cooling. This eliminates waste material from using up refrigeration and speeds up the packaging operation following cooling. On corn tests, for example, ears which had to be cut to size following cooling, the temperature had risen to 51°. Cutting before the cooling operation resulted in a 6 degree reduction (45°) when placed in storage. This reduction in temperature under normal refrigeration would require 2 to 3 days, or even longer. Corn may lose 30% of its sugar in 24 hours at 65°F. At 35° this loss is only about 3% (5). A reduction from 60°F. to 40°F. lowers the heat evolved

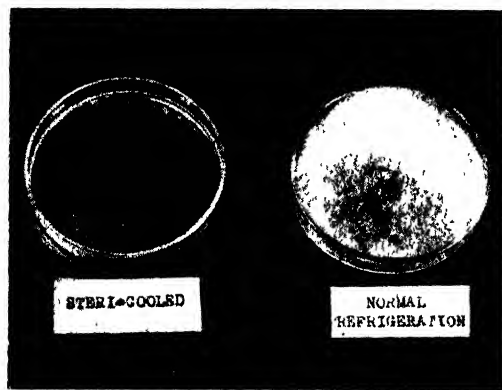
by respiration more than 50%. So it is easily seen how important pre-cooling really is to maintain freshness.

The Steri-cooler liquid contains a germicide designed principally to prevent contamination and build up of organisms in the treating solution. This combined with the quick reduction in temperature of the product treated almost entirely eliminates chance for development of rot producing organisms. Few, if any, of the common transit decays continue to develop at 40°F and lower.

In order to demonstrate the effect of rapid cooling on various organisms commonly attacking fruits and vegetables, we con-



ducted a special experiment. Petri dishes inoculated with these organisms were held under conditions similar to those produced by Steri-cooling followed by normal transit refrigeration. The check or control sets were held under conditions of normal transit refrigeration. After what was considered normal transit period, these plates were returned to normal room temperature.



The accompanying photographs of plates inoculated with Rhizopus Rot (*Rhizopus Nigricans*) were taken after 48 hours. The plate held under conditions of normal transit refrigeration has developed extremely heavy growth with very abundant formation of spores, whereas the plate representing Steri-cooled conditions shows only slight growth and no spores whatsoever.

We do not wish to imply that the Steri-cooler will not eliminate the necessity of maintaining adequate sanitary conditions. A sound routine sanitary cleanup should be put into practice for prepackaging, and should be as thorough as in any other food processing plant. Bacteria, especially the soft rot organism, builds up on plant juices and debris especially around cutting knives, belts, and where trimming is done. Yeasts and molds also develop along with bacteria, and may result in heavy contamination of produce at these points if not kept clean at all times. Poured culture plates for instance, of swabs taken from the cutting belt in the corn operation gave such an

abundance of growth that counts could not be made even at a 1 to 10,000 dilution. These points of possible contamination were soon eliminated by the proper clean up. The importance of sanitation will certainly become more evident as prepackaging develops on a larger scale.

As you may have observed from Table I by this time pre-cooling also saves subsequent refrigeration. For once the product is cooled, less refrigeration is needed to maintain low temperatures. Since the product continues to give off heat, normal cooling actually requires additional refrigeration.

In summary then, preparation for prepackaging should include (1) the removal of the inedible portion—which reduces transportation and refrigeration costs, (2) proper sanitary conditions to prevent contamination, and (3) pre-cooling such as Steri-cooling to insure against loss of freshness and nutritive qualities caused by high respiration rate and also by decay producing organism.

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# MERCHANDISING OF PRE-PACKAGED FOODS

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The pre-packaging program of fresh fruits and vegetables bring together for the first time in the long history of agriculture, representatives of every essential operation, from the field to the table; *our government, the grower, the scientist, the engineer, the merchandiser and the consumer*-- to accomplish, through co-operative effort, what might well be termed the complete re-birth of the industry.

Up to now, from the point of shipment to the consumer, the produce industry has been doing business from the same old stand that it did in the cracker-barrel days. The success of pre-packaging at the grower-shipper level will put the farmer in a more vital position. He has made great progress in applying science and engineering to his profession in the development of soils and crops. Although he can hardly be blamed for considering his job finished when his products are produced and delivered, every day the logic of pre-packaging fresh fruits and vegetables at the point of origin, the farm, is gaining steadily.

The elimination of all bulk waste, such as trimmings of the tops and leaves at the point of origin *before* shipment reducing the handling and waste caused by manuling of packers, carriers, wholesalers, retailers and finally the consumers; value of proper refrigeration at the moment of harvest before spoilage begins--these are among the advantages indicated by pre-packaging at the point of origin.

The preparation and marketing methods of practically all other forms of food are geared to modern up-to-the-minute self service merchandising. The successful packaging of grocery products has sounded the death knell of former selling methods.

Such staples as coffee, tea, crackers, rice, beans, sugar, some meats and many other products now sold exclusively in packages, indicate customer preference. The pack, container, wrapper, the brand name--and self service--all court the housewife. She knows her pet brand of dog food is nutritious, clean, made in a scientific factory, the dog food company has told her so on his package. But the farmer has never been able to tell her anything about himself or his product, because he has no package. For him to put his perishable produce in a consumer package mark his brand on it and tell the housewife just how he works to raise quality foods and deliver it to her "field fresh"--that is one of the ultimate objectives of the pre-packaging program. This function also will entitle the farmer to some of that 300% mark-up between him and the consumer.

In this revolution within the food industry the predictions are:

Tomorrow's food store will be less of a work shop and more of a service center.

Tomorrow's grocery store will place more emphasis on merchandising, store atmosphere menus, budgets, new ideas, cleanliness, service and friendly courtesy.

Many functions of the present day retail food store will probably be shifted to the packaging plant. Therefore it will pay all of us in the food industry, not only to watch this trend but to help develop it.

Today in Columbus, Ohio, in the self-service super-markets that have made a test conversion to selling only packaged fresh produce, the fruit and vegetable departments are clean and orderly beyond any storekeeper's dream. There is no waiting or lurching of customers as they walk down the row of refrigerator cases, free to pick up and examine the crispy cool packages of fresh peas, golden ears of sweet



corn, sparkling radishes, head lettuce, all sealed in transparent wrappers. There is no wilted nor discarded vegetable litter on the floor. Everything on display is just as fresh at five in the afternoon as it was when the store opened in the morning.

All this, and at no increase in retail prices to the consumer, seems almost too good to be true. Yet everyone connected with the Columbus experiment, believes that it is economically sound. Since its modest beginning about four years ago in a corner of one of the super-markets, the returns at the cash register, where public opinion is voiced, have been consistently ahead of sales in the old-line stores. However, I should say here that there is still a question of whether or not pre-packaged fruits and vegetables can be successfully retailed at the same cost as unpre-packaged produce. Most experiments have been conducted for too short a time to fully answer this question. In some experiments now being conducted, no comparison is possible.

A casual observer might credit this success to the self-service idea, to attractive appearance of packaged-perishables, to gleaming new counters on which they are displayed. These are all very important factors of course, but not the important one. The approval of the housewife is won by elimination of waste. Waste is costly all around. It hits the grower by lowering his prices; it robs the storekeeper and finally it shorts the housewife—far more than most of us realize. One official of the War Foods Administration has estimated that *one-fifth* of our leafy green vegetables are lost in the retail store and at home, and that *one-third* of all fruits and vegetables is wasted between the field and the consumer's stomach.

Spending a fraction of a cent per head of lettuce, for wrapping and refrigeration, to preserve its freshness and salability in the store, is good business for all concerned. It becomes smart merchandising, when consumers discover the fact that lettuce, sweet

corn or snap beans—so handled—also keep better after they get them home.

Scientific analysis and controlled store tests are saying that packaging and refrigeration are doing the job of merchandising of fresh produce. However, the real testimony of the shoppers themselves is the "clincher." Thorough tests in merchandising of fresh commodities prove that the majority of consumers favor this type of service. Almost nine out of every ten customers (86.3% of the total number responding to questionnaires given out in tested markets) preferred to buy pre-packaged foods rather than those in the bulk. As the most favorable response came from the stores that had been selling pre-packaged fresh produce the longest one may conclude that the more accustomed the consumer becomes to the idea the better he likes it.

Some of the reasons advanced were:

- (1) Produce sold in packages is of better quality and appearance.
- (2) Produce is more sanitary, inasmuch as it is sealed and protected from constant mauling, pinching and handling.
- (3) Produce, pre-packaged, makes for quicker shopping.
- (4) This new method permits a better choice at late hours of the day.
- (5) Kitchen preparation and waste disposal in the home is easier.
- (6) Packaged produce keeps longer than the bulk and it is handier to store in the refrigerator.

Chief objections to pre-packaged produce were:

- (1) Some commodities were packed in too large units.
- (2) The package itself did not permit sufficient visibility, to make a careful choice.
- (3) Quality of the product was not dependable.

However, of these objectors, 69.9% still preferred pre-packaging to buying in the bulk.

Store managers of the stores making these tests, say that it helps make them more profit. Actual profits on bulk fruits and vegetables are generally difficult to determine. Seldom do stores have records revealing losses in trimmings, throw-away, and cost of labor. But products that are sorted, cleaned, trimmed and packaged *do* have definite cost, meaning assured profits to the storekeeper and permits him to keep more accurate records of his produce department.

Significant challenge to the packaging of fresh-produce by the industry, if it is to do an adequate merchandising job are many:

(1) The package must attract attention. It must compete effectively in the all-important split-second to catch a prospective purchaser's eye and hold it. It must be a "shopper-stopper" in every sense. The progressive retailers of all classes realize that much of Mr. and Mrs. Consumer's buying is done through impulse. As a result, store layouts are constantly being designed to permit maximum display and maximum opportunity for self selection and self-service. Packaging has an opportunity to fit into this self-service program by adequately supplying the factors that are important to both consumer and dealer—to become an advertisement and a salesman. This is the responsibility of the package.

(2) The package must tell the story of the product. What is it—what count or weight, how much, etc. It must be remembered, it must compete for attention with at least 2,800 other products in an average grocery store.

(3) The package must build confidence. Is it the quality wanted? Is it fresh? Is its original quality fully protected? These are some of the questions the average consumer wants to know. The package must be depended upon to supply these answers.

(4) The package must look clean and sanitary. Food shoppers especially women shoppers, are becoming more and more sanitary-conscious as a health protective measure.

(5) Packages must look like good values. Millions of housewives have found their dollars do not go very far. Consequently the package that looks like "Full money's worth" is likely to produce assurance.

(6) The package must be convenient to handle. Convenience of handling in the store, to carry out of the store and use in the home is very important and becoming more so every day.

In addition to these consumer challenges, there are several other factors the dealers feel are important.

(1) The package must look like a fast seller. The shrewd retailer knows that fast turn-over in his produce department is one of his principal goals. His experience concerning which size of package sells and which doesn't will be drawn on in making his decision whether to stock the packaged item offered. It will be only sound judgment to submit proposed package to a jury of able retailers so that their reactions will be available in correcting faulty unit size, if any exist.

(2) The effective package must minimize the selling time of the clerks required. The package that answers questions, tells its story quickly means faster handling of store traffic—very important—during peak hours.

(3) The package must prevent spoilage during selling period. Failure to provide necessary protection means non-salable merchandise, or worse still a dissatisfied customer and a complaint.

The produce world should not become discouraged at the slow progress of the pre-packaging program now begun in various parts of the country. When any industry

makes revolutionary changes in its methods, changes must tumble all down the line. Changes in type of freight cars, new refrigeration, new cargo airplanes, new style grocery markets, and even changes in the kitchen follow a new process, also warehouses, wholesale houses and even the farmer should conform to the new methods.

So, all the long channel from the farmer to the consumer, many changes will have to occur in the care of packaging of fresh produce. Therefore time must elapse before this entire program can come into general use. Meanwhile, should inexperienced packers flood the market with large quantities of poor quality pre-packaged fruit and vegetables, it would mean a setback in consumer acceptance gained thus far in these new methods of merchandising and halt the progress so vitally needed.

For example, the tomato package right now is meeting with considerable consumer resistance, due to the poor quality packed by terminal receivers.

Our biggest bottle-neck in the merchandising of pre-packaging of fresh fruits and vegetables is the fact that less than 1% of the retail outlets have proper refrigerated cases to display properly the packaged produce. The case manufacturers, like so many others, are behind in their orders.

When cases are available, the merchandising of pre-packaged produce will have to be an educational program. Merchandising meetings should be held with co-operative chain stores, voluntary groups,

store managers and all retailers planning to handle pre-packaging units.

The grower will, in all likelihood, have to carry newspaper advertisements in the market he serves in order to make the consumer accept his brand.

If pre-packaging is to be done at the grower's level, the smart grower, or the co-operative representing the grower, will need to add advertising and merchandising personnel to his, or its, organization. This would be similar to the methods already practiced by those dealing in frozen foods program and the canning industry.

To successfully merchandise pre-packaged produce by the grower, there must be a follow-through *from the field to the table*. Old methods of the wire or telephone must be supplemented by contact men. We know the housewife likes the pre-packaged foods—it is up to us to by-pass some of the old distribution methods.

Self-service food stores are definitely here to stay. To fill their need, the produce department must also be self-service.

Now who is going to do this job? The terminal crowd who have been the "gongers" of the growers or is the grower himself going to accept the challenge and take the short cut to the consumer? Before that can happen completely, many questions will have been answered, the old rule of trial and error will have been applied.

It may come sooner than any of you think!

# CHEMICAL CONTROL OF WEEDS IN VEGETABLE SEEDBEDS

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The increasing cost of agricultural labor in the years since the beginning of World War II has created greater and greater demands for weed eradicating chemicals. Some such materials were already available by 1941 and others have been developed since then. Our interest at the Vegetable Crops Laboratory (11) has been directed primarily toward an investigation of the herbicidal materials which might be usable for the control of weeds in vegetable seedbeds. Both Uramon and Cyanamid have become widely used as weed control materials for tobacco seedbeds in the southeast during the last 3 years. Clark (1) and Kincaid (7) working in North Florida recommend use of these materials individually or as a mixture applied to the soil 3 months in advance of planting. Henderson (4) makes the same recommendations for Virginia. Another chemical having herbicidal properties is Chlorpicrin (manufactured and sold under the trade name "Larvacide"). This compound has been used extensively both as a weed killer, (10) (6) (2), and a nemacide (5). Chlorpicrin is currently recommended as a soil fumigant for tobacco seedbeds by Swanback (12), in Connecticut. The use of 2,4-dichlorophenoxyacetic acid as a soil treatment for weed control has recently been pointed out (3). The material used in proper concentration may act either as a stimulant to soil organism (9) or may greatly accelerate the initiation of root primordia in the stems of plants produced on treated soil (8). These three herbicidal materials have been used as seedbed soil treatments during the past crop season. All experiments were set

up so that data could be subjected to statistical analysis. The soils used were of both sandy (Leon) and heavy (Manatee) types which were known to be infested with seeds of our common weeds.

Seedbeds to be treated were made up and the herbicides applied to each randomized block in such order that a single bed having all 3 herbicides could be planted at 1 time. Fertilizers were applied 1 week in advance of planting at the rate of 2000 pounds per acre. Two kinds of irrigation were employed, 1 set of beds was watered from overhead by means of a hose and sprinkling nozzle, the other was watered by seepage whereby water ran along either side of the bed in a shallow ditch. To accentuate the effects of herbicide as regards weeds 2 crops were employed, tomatoes, a short term crop and celery a long term crop.

A 3:1 Uramon + Cyanamid mixture was used; 1.5 lbs. per sq. yd. on the heavy soil, and 0.5 lbs per sq. yd on the light soil. The material was broadcast uniformly over the soil surface and then mixed thoroughly to a depth of 4 inches. Intervals of 4 and 10 weeks were allowed to pass before planting.

Chlorpicrin was applied at the rate of 2.5 cc per sq. ft. as recommended by the manufacturer. Intervals of 2 and 8 weeks were allowed before sowing.

The ammonium salt of 2,4-dichlorophenoxyacetic acid was applied as a liquid application equivalent to 10 lbs. per acre. As with Uramon + Cyanamid periods of 4 and 10 weeks intervened between seedings.

Plant counts were made after germination to determine the total number of seedlings. Final harvest records separated the plants into two categories, number ones, and culls. With tomatoes, a plant which measured 4 inches from the soil surface to the bud was considered a number 1 plant. With celery,

a plant which measured 4 inches from the soil surface to the tip of the longest leaf was a number 1 plant.

A consideration of crops shows that germination (Table 1) of tomato seeds was not reduced by any of the 3 herbicides. Chlorpicrin was significantly better than 2, 4-D. With celery, the check plots were better than Uramon + Cyanamid which in turn was better than 2, 4-D. Chlorpicrin plots showed no reduction in plant stand.

A consideration of date shows the same relative position of significance for the 3 herbicides for plots seeded in December. On plots seeded in January there is no sig-

translocated by the irrigation water into the centers of the seedbeds. This loss often represented all of the plants in the center of the bed.

At final harvest (Table 2) the production of tomato plants was reduced significantly by the 2, 4-D treatment. The yield of number one celery plants in Uramon + Cyanamid and Chlorpicrin plots was significantly better than the checks which in turn were better than the 2, 4-D treatments.

The figures for date indicate that for December seedlings Chlorpicrin plots were significantly better than Uramon + Cyanamid or Check plots which in turn were

TABLE 1  
EFFECT OF HERBICIDES ON GERMINATION OF TOMATO AND CELERY SEEDS

Soil Treatments	Crops		Date Planted		Irrigation	
	Tomato	Celery	December	January	Overhead	Seep
Check	9493	6665	7700	8458	8609	7549
Uramon + Cyanamid	9746	5425	6854	8317	8456	6715
2, 4-D	9274	3637	4997	7914	7722	5189
Chlorpicrin	10192	6516	8479	8229	8721	7987
Difference for Sig. 5% level	809	809	809	809	809	809

nificant difference in the number of seedlings produced. The reduction in germination in the Uramon + Cyanamid and 2, 4-D plots took place mainly in celery plots sown 4 weeks after application of the herbicides. A study of the figures on irrigation reveal a significant reduction in germination on the Uramon + Cyanamid and 2, 4-D plots which were seep irrigated. This reduction in germination of celery (field observations showed some loss of tomato plants) can be attributed to sowing Uramon + Cyanamid and 2, 4-D plots too soon after treatment. Soil tests\* show that this reduction is due to a concentration of salts which have been

better than 2, 4-D. January showed Chlorpicrin and Uramon + Cyanamid no better than the checks and only Uramon + Cyanamid significantly better than 2, 4-D. There was significant loss in plant production due to type of irrigation. With overhead irrigation, Chlorpicrin was significantly better than Uramon + Cyanamid or Check plots which in turn were better than 2, 4-D. With seep irrigation Chlorpicrin, Uramon + Cyanamid, and Check plots were better than 2, 4-D.

\*Made in conjunction with the seedbed work by Dr. E. L. Spencer, Soils Chemist

TABLE 2

EFFECTS OF HERBICIDES ON THE PRODUCTION OF NUMBER 1 PLANTS AT FINAL HARVEST AND TOTAL NUMBER OF WEEDS

Soil Treatment	Crops		Date Planted		Irrigation		Total No. Weeds
	Tomato	Celery	December	January	Overhead	Seep	
Check	2123	2551	2403	2271	2894	1780	13846
Uramon + Cyanamid	2398	3646	3293	2751	3246	2798	8387
2, 4-D	462	1085	57	1490	927	620	5950
Chlorpicrin	3121	3731	4389	2463	4481	2371	10566
Difference for Sig. at 5% level	1075	1075	1075	1075	1075	1075	3515

For weed control 2, 4-D was significantly better than Uramon + Cyanamid, Check or Chlorpicrin plots. Uramon + Cyanamid was significantly better than Check plots but not better than Chlorpicrin.

Weeds found growing on the heavier type Manatee soil were mostly of a succulent nature: smooth and spiny pigweed, purslane, and sow thistle. The sandy type soil was heavily infested with such grasses and woody annuals as, red top, goose grass, sorrel, dog fennel and Jerusalem oak. Nut-grass, Bermuda grass and crabgrass were common to both soils. Chlorpicrin failed to give adequate control of crabgrass and gave only a mediocre control of redtop and purslane. Observations at time of seeding the beds indicated a good control of all weeds by chlorpicrin but as the season progressed more and more crabgrass germinated in these plots. Subsequent trials with Chlorpicrin, in which steamed soil was sowed with crabgrass seed and then treated, indicate that Chlorpicrin inhibits seed germination for several weeks but does not kill the seeds. Uramon + Cyanamid gave good weed control on heavier type soil where the application was sufficiently high. 2, 4-D gave excellent control of all weeds and grasses named except Bermuda grass. The figures given in Table II represents this species almost altogether.

## CONCLUSIONS

The results obtained in these experiments as regards the control of weeds by soil application of herbicidal material correlated with crop, time of planting and irrigation indicate that:

1. Uramon + Cyanamid is effective as a herbicide. Regardless of type of irrigation seed should not be sowed for at least 6 weeks after treatment.
2. Chlorpicrin is stimulative in its effect on tomato (not significantly so) and celery plants. It gives adequate control of all native weeds other than crabgrass. It should not be used as a herbicide in soils known to be heavily infested with seeds of crabgrass. Best results are obtained by planting 2 weeks after treating the seedbed.
3. The Ammonium salt of 2, 4-dichlorophenoxyacetic acid cannot be recommended as a herbicide for vegetable seedbeds.

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## OBSERVATIONS OF CERTAIN FACTORS GOVERNING EFFICACY OF SOIL FUMIGANTS

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Compared with efforts expended in foliage problems, control of below-the-ground pests and pathogens has been a neglected field. Although little is yet known regarding the nature of organisms causing damage through plant roots, the enormous extent of crop losses from such organisms has been strikingly demonstrated by the use of soil fumigants. Soil fumigation appears to offer a logical and practical means of controlling harmful and undesirable soil organisms and increasing crop yields and quality. There are now four or five manufacturers of fumigants carrying on an intensive screening program with volatile chemicals. Literally hundreds of fumigants have been tested against various soil fungi, insects, nematodes and weed seeds and many promising ones have been found. Also much fundamental

knowledge is gradually being acquired regarding factors affecting the performance of fumigants. There is a great need for intensive work along these lines by local experiment station workers, and it is hoped that the following generalized discussion will be a thought provoker and research stimulator.

The fumigants now being used commercially in Florida are chloropicrin (Larvacide), methyl bromide (Isobrome), dichloropropene-dichloropropane mixture (D-D) and ethylene dibromide (Soilfume 60-40, Soilfume 80-20 and Dowfume W-40). Their respective merits have been discussed in other papers. All of these fumigants are relatively insoluble in water, but vary considerably in their molecular weights, boiling points and vapor pressures. They are all applied beneath the soil surface as liquids and function in the soil as gases.

*Spacing and Depth of Applications*—Studies of fumigant diffusion in soil have shown

that the diffusion pattern is ordinarily like a bottle or a flask with a tapering neck. It can be readily understood that the spacing of application points or rows should be close enough and the depth of applications be shallow enough so that the point at which the pattern begins to taper be as close to the soil surface as possible; also so that the various diffusion patterns meet or preferably overlap at all points. With the flask picture in mind, it can be understood that the upper inch or two of soil is the most difficult area to fumigate effectively. Spacing can be wider in sandy soils (say, 12 to 14") than in clay and muck soils (say, 8 to 10"). It is advisable to make applications as shallow as possible and still retain the fumigant in the soil. Depth of application should be increased, particularly in sandy soils, when soil temperatures are high and/or soil moisture contents are low.

*Penetration*—From the point of application the fumigant must penetrate throughout the soil mass to the desired depth, into rotting roots and other organic debris, and then be retained long enough to kill various forms of inoculum. Factors affecting diffusion, such as soil temperature, soil porosity, soil moisture content, degree of sorption, molecular weight and vapor pressure of the fumigant determine the degree and rate of penetration. The fumigants in use are all heavier than air so that downward penetration is usually no problem. Sometimes, as in the treatment of sandy seed beds with chlorpicrin, it is desirable to limit downward penetration of the fumigant by raising the water table. Owing to the difficulty of penetrating unrotted or partially rotted roots, it is desirable to allow such organic debris to thoroughly rot before treating the soil. The principle reason for the comparative inferiority of chlorpicrin against the root knot nematode is its inability to kill all stages of the nematode in roots that are not thoroughly disintegrated, whereas methyl bromide, D-D and ethylene dibromide have this ability when applied under favorable conditions. It is also suspected

that general penetration of the fumigant is hindered by air pockets surrounding organic debris, in that the gas settles in these pockets. Penetration into surface ridges and lumps is difficult; hence the importance of having the surface thoroughly levelled following application of the fumigant.

*Soil Temperature*—In general soil fumigants are most effective at soil temperatures between 50° and 80° F. At low temperatures sorption of the fumigants by soil particles is greater, volatilization and diffusion are lessened, and the period of retention in soil is prolonged. At higher temperatures loss of the fumigant at the soil surface is more rapid. Materials with a low boiling point, like methyl bromide, are more effective at lower temperatures and less effective at higher temperatures than chlorpicrin, D-D and ethylene dibromide which have higher boiling points. At high temperatures the fumigant should be applied deeper, the soil moisture content should be higher and, in the case of chlorpicrin and methyl bromide, greater attention should be given to sprinkling the soil surface with water. Muck and clay soils can be treated more effectively at higher temperatures than sandy soils.

*Soil Moisture*—It is difficult to state the ideal soil moisture content levels for best results from soil fumigation. Since the fumigants are all only slightly soluble in water they are not able to penetrate a wet soil. Similarly a high water table can stop downward penetration of the fumigant, or, on rising, force it out of the soil. A heavy leaching rain can push the gas downwards; and a light rain or artificial sprinkling can help seal the fumigant in the soil and materially aid in results obtained with chlorpicrin and methyl bromide. In dry soil the loss of gas is often too rapid. Pre-conditioning of soil with moisture is known to be very important in regard to killing of weed seeds with chlorpicrin, and this may apply to other organisms and other fumigants. When soil temperatures are above, say 75°, the soil moisture content, particularly in sandy soils, should be higher. Clay soils and prob-



ably mucks, should be fumigated at lower moisture levels than sandy soils

*Soil Type* — Diffusion of fumigants through more porous sandy soils is easier than through less porous clay soils. Also sorption of these gases, principally by the colloidal soil particles, is greatest in clay, second in muck and least in sandy soils. Although gas sorption is not as great in muck as in clay, it is apparently more prolonged. In general, clay and muck soils should be fumigated with higher dosages, shallower applications, in looser condition,

at lower soil moisture contents and at higher temperatures than sandy soils and a longer period should be allowed for aeration

*Rates of Application*—The usual rates of application are about 500 lbs. of chlorpicrin, 200 lbs. of methyl bromide, 200 lbs. of D-D and 50 lbs. of Ethylene dibromide per acre. Dosages are increased somewhat when soil conditions are adverse for retention or diffusion of gas. Also heavier dosages are applied in muck and clay soils than in sandy soils.

## WIREWORM CONTROL STUDIES ON THE LOWER SOUTHEASTERN FLORIDA COAST, 1946-47

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There is no question but that serious losses from wireworms have been sustained by potato growers in South Florida. The important question is how can the losses be stopped. This report records results of rather extensive experiments conducted in the 1946-47 season on the use of insecticides for wireworm control. An enumeration of three characteristics of the wireworm problem in South Florida is as follows: (1) one of the corn wireworms, *Melanotus communis* Gyll. is the insect involved, (2) most of the insects complete their life cycle in one year, as shown by Wilson<sup>1</sup>, and (3) most of the insects are in the larval stage during the entire potato growing season. Adaptation of control measures found effective elsewhere may not be effective in South Florida, nor do the

differences necessarily preclude an easier solution to the problem

Some of the newer insecticides were tested to determine their effectiveness in wireworm control. They included DDT, benzene hexachloride, termed HCH (for 1, 2, 3, 4, 5, 6-hexachlorocyclohexane) in this report, and the fumigants dichloropropane - dichloropropylene under the proprietary names of *D-D*, and *Dowfume N*, and ethylene dibromide, or *Dowfume H-10*.

All experiments were conducted on the calcareous or marl soil in commercial fields of potatoes of South Dade County. This soil is alkaline and was found to range in pH between 7.5 and 8.7. It might be questioned, owing to the alkalinity, how DDT and benzene hexachloride could be effective in wireworm control, since both insecticides are understood to decompose in alkaline media. Some wireworm control, however, was obtained.

### FIELD EXPERIMENTS

In cooperation with the Farsouth Growers Cooperative Association an experiment was conducted in which different concentrations

<sup>1</sup> WILSON, J. W. Present status of the wireworm in South Florida. *Proc. Fla. State Hort. Soc.* for 1946: 103-106.

TABLE 1—WIREWORMS PER SQUARE FOOT ON SAMPLING DATES, PERCENTAGE OF TUBERS INJURED, PERCENTAGE OF CONTROL, AND YIELDS OBTAINED

Treatment	Wireworms per sq. ft on			% tubers injured	% control	Yield bu./A.
	6/28	7/21	10/31			
DDT—50% W.@16.2 lbs./A.	0.05	1.13	0.57	10.7	--3	251
DDT—50% W.@32.4 lbs./A.	0.09	0.85	0.95	9.8	6	246
DDT—50% W.@64.8 lbs./A.	0.05	1.01	0.57	5.2	50	251
Check	0.42	1.18	1.98	10.4	—	263
Sq. ft of soil sampled per treatment	21.2	21.2	10.4			

Planted December 2, 1946, and harvested February 20, 1947.

of DDT were sprayed on the ground and then disked in. Three concentrations were applied in 25-foot strips across an 80-acre field, on May 13, 1946. This was subsequent to the potato growing season, preceding the rainy season, and during the egg deposition period of the wireworm adult. The soil was disked after treatment in order to place the DDT below the surface.

Samplings of the soil were made at three different times after the treatment to determine the wireworms populations. The results of the samplings and of the percentage of the tubers injured and of the yields at harvest time are presented in Table 1.

More wireworms were taken in the check samples than in the samples from treated soil, on each sample date. As many wireworms were taken from the 16.2-pound concentration of 50% wettable DDT per acre as from the 64.8-concentration on each sampling date, except July 21 and it was nearly so. It is of interest to note however, that the percentage of injured tubers showed an order of decrease with DDT concentration increase. Possibly the slowness of action of DDT may in part explain these observations. Although the average yield figure is slightly more for the check than for the plots treated with DDT the differ-

TABLE 2—MATERIALS AND AMOUNT OF SOIL FUMIGANTS USED, AVERAGE PERCENTAGE OF WIREWORM INJURED TUBERS, PERCENTAGE CONTROL, AND AVERAGE YIELD

Material and amount applied/acre	Avg. % injured tubers	Percentage control	Avg. yield bu. per A.
D-D —22 gals. (220 lbs.)	8.5	21	235
W-10—22 gals. (161 lbs.)	4.5	58	235
N —26 gals. (260 lbs.)	7.5	31	234
Check	10.8	—	256

Planted December 2, 1946, and harvested February 20, 1947.

ences are within the limits of chance occurrence and are considered insignificant.

The soil fumigants were arranged in treated strips 12-feet wide across a field about 1250 feet long, also in cooperation with the Farsouth Growers Cooperative Association and with the companies marketing these proprietary fumigant mixtures. Dispersion of the fumigants was by a fumigant applicator, one with injector tubes spaced 12 inches apart, injecting the fumigant at from 6 to 9 inches in depth and at intervals of 15 inches in each row. The fumigants were applied on November 7 and the field was planted December 2. At harvest time, in February, samples of tubers were dug,

More control of the wireworm is shown by the *W-10*, ethylene dibromide material than by the other or of the check. The four bushels difference in yield is regarded as insignificant.

In cooperation with Mr. August Burrichter an experiment was conducted in which 11 treatments, including a check, were used. The 44 treatment plots were each four rows wide by about 300 feet long, comprising a tract of approximately 4 1/2 acres. The insecticides DDT and HCH were applied by different methods. Each was used as follows: (1) as a wettable powder broadcast and then disked in the soil, (2) as a dust, presumably without a wetting

TABLE 3—WIREWORM INJURED TUBERS, PERCENTAGE CONTROL, AND YIELD FROM TWO SOIL FUMIGANTS

Material and amount applied/acre	Avg. % injured tubers	Percentage control	Avg. yield, bu. per A.
W-10—22 gals. (161 lbs.)	7.2	59	238
N —26 gals. (260 lbs.)	11.2	36	241
Check	17.4	—	242

Planted December 2, 1946, and harvested February 20, 1947

weighed for yield, and determined as to wireworm injured tubers. The results are summarized in Table 2.

The ethylene dibromide *W-10*, gave the best control, 58 percent. The other mixtures were less efficient. The check samples yielded more than the treatments, but the differences are attributed to chance occurrence.

Another comparison involving the *Dow-fumes W-10* and *N* fumigants with untreated (check) soil were also obtained from other treatment strips in the same field. The applications were made by the same method, on the same day as above stated. A summarization of the results is presented in Table 3.

agent, broadcast and then disked in, (3) mixed with fertilizer and applied in bands at the side of the rows at planting time, and (4) the wettable material of each insecticide was dusted on the cut potatoes before they were planted. The soil fumigants *D-D* and *W-10* were also included in the experiment for further comparisons. The results are presented in Table 4.

The fewest wireworm injuries were found on tubers grown in soil that had been treated with HCH broadcast, applied at three pounds of the gamma-isomer per acre, but the yield was also reduced. The fumigants each gave 63 percent control, without significant yield differences as compared with the check. The seed piece treatment

TABLE 4—EXPERIMENTS AT BURRICHTER'S LISTING TREATMENT, MATERIALS, AMOUNTS USED PER ACRE, AVERAGE PERCENTAGE OF TUBERS INJURED BY WIREWORMS, PERCENTAGE OF CONTROL, AND YIELD IN BUSHELS PER ACRE

Treatment material	Amt. used Lbs./Acre	Avg. %		Percentage control	Yield bu. per acre
		Injured tubers	wireworm		
DDT—Wettable, 50%, b'cast, disked in <sup>1</sup>	50	10.5	15	213	
DDT—Dust, 50%, b'cast, disked in <sup>2</sup>	50	10.9	13	208	
DDT—Wettable, 50%, with fertilizer <sup>1</sup>	138	7.8	37	201	
DDT—Wettable, 50%, seed piece treatment <sup>1</sup>	30	5.9	44	138	
HCH—Wettable, 6% gamma-isomer, b'cast, disked in <sup>1</sup>	30 (1.5)*	6.0	51	222	
HCH—Dust, 1% gamma-isomer, b'cast, disked in <sup>2</sup>	300 (3.0)*	3.0	76	124	
HCH—Wettable, 6% gamma-isomer, with fertilizer <sup>1</sup>	139 (8.3)*	6.6	46	212	
HCH—Wettable, 6% gamma-isomer, seed piece treatment <sup>1</sup>	29 (1.7)*	Nearly all tubers failed to sprout			
W-10 <sup>4</sup>	32 gals	4.6	63	234	
D-D <sup>5</sup>	25 gals (254 lbs.)	4.6	63	253	
Check	—	12.3	—	253	

(\* 1 lb. gamma-isomer per acre.)

Wireworm population sampled (25 cores, each 0.53 sq. ft. area) October 28, 1946, was 1.02 wireworms per sq. ft. Treatments made October 8, 1946, and tubers planted November 19, 1946.

<sup>1</sup> Obtained from California Spray Chemical Company<sup>2</sup> Obtained from Pennsylvania Salt Company<sup>3</sup> Obtained from Commercial Solvents Corporation<sup>4</sup> Obtained from Dow Chemical Company<sup>5</sup> Obtained from Shell Agricultural Chemicals

with HCH was fatal to nearly every seed piece treated.

Results of an experiment involving about 10 acres, in cooperation with Farsouth Growers Cooperative Association, are presented next. Different amounts of DDT and HCH were added to the fertilizer. The insecticide-fertilizer combinations were applied at planting time, in bands 2 inches wide, 2 inches at each side and 1 inch below the seed pieces. The planting was made December 2 and 3, 1946, with the Sabago variety. A summary of the data is given in Table 5.

now be recommended. If improved manufacturing processes can eliminate the taste contaminant, it may be found suitable for wireworm control.

Real reductions of wireworm injuries resulted from the use of the fumigants but more nearly perfect control had been expected from these materials. It is likely that improvements in the preparation of the soil or in the application methods may be found more effective in the marl soils. Some consideration from different viewpoints may provide more understanding and improvement of the methods of application.

TABLE 5—FERTILIZER-INSECTICIDES COMBINATION, WIREWORM CONTROL AND YIELDS

Material and amount applied/acre	% injured tubers	Percentage control	Yield bu per acre
DDT - 50% W. @ 17.6 lbs.	43	-- 2	134
DDT - 50% W. @ 35.2 lbs.	49	-- 17	129
DDT - 50% W. @ 70.4 lbs.	37	12	128
HCH - 50% W. @ 17.6 lbs. (0.88)*	24	43	135
HCH - 50% W. @ 35.2 lbs. (1.76)*	20	52	131
HCH - 50% W. @ 70.4 lbs. (3.52)*	21	50	127
Check, fertilizer only	42	—	132

\* Pounds of gamma-isomer per acre.

Insecticides furnished by E. I. duPont de Nemours and Company.

Planted December 2 and 3, 1946, and harvested March 8, 1947.

Benzene hexachloride gave some wireworm control at all three dosages tried; DDT may be said to have given no control. The yields differed but little among the treatments.

#### DISCUSSION OF RESULTS

Wireworm control was obtained from treatments of benzene hexachloride and of the three fumigants. One pound of the gamma-benzene hexachloride per acre appears to have been practically as effective as more than one pound. Unfortunately, there was a taste contamination of the tubers from the use of this material, and more definite taste where heavier dosages were applied per acre, so that it cannot

The grower considers his soil tilth and conditions for a good seedbed before the tubers are planted. Cover crops are one need of the soil and may consist of tall sesbania, heavy grass sod, rank ragweed growth, a dense covering of velvet beans, or combinations of all. Growers who wish to use the fumigants may have to change some cultural practice to obtain maximum results from the fumigants.

From the viewpoint of effective gas fumigation thorough permeation of all of the soil by the fumigant is a definite requirement. This may necessitate breaking up the sod, lumps of soil, and the plant constituents of the cover crops as if the seedbed were in preparation. It means that the seedbed so

prepared would be fumigated and left undisturbed for two weeks. After the period allowed for fumigation, the soil would need to be disked or harrowed to eliminate the weeds before the seed are planted, although the fumigant would inhibit some plant growth. Lange<sup>1</sup> reports that factors such as: "... soil temperature, soil type, soil texture, absorption, composition, compactness, and soil moisture, amount of fumigant used, correlation of time of treatment with the known behavior of the organism to be killed, the type of seal used following treatment and other factors" influence the effectiveness of treatments. The type, texture, composition, and compactness of the soil and the disposition of the cover crops are suspected as factors that need to be studied with regard to effective fumigation of the marl soils of South Florida.

<sup>1</sup> LANGE, W. HARRY. New development in soil insecticides. *Agr. Chem.* 2 (2) 20-23. 68-71 1947.

The stronger dosage concentrations of DDT applied during the month of May provided measures of wireworm control. Those applications made just before or at the time the tubers were planted were comparatively ineffective. For marl soils, indications are that (1) heavier dosages such as 70 pounds of 50% DDT are required, and (2) it is slow acting, requiring weeks or even months to effect control.

#### SUMMARY

Partial control of wireworms was obtained by spraying soil with DDT about 6 months before planting potatoes, by treating soil with benzene hexachloride or by adding the chemical to the fertilizer and by fumigating with dichloropropane-dichloropropylene, or ethylene dibromide. The more promising results were obtained with the fumigants and benzene hexachloride.

## THE USE OF SOME ORGANIC INSECTICIDES IN THE CONTROL OF EARWORMS ATTACKING SWEET CORN

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Ever since the oil + pyrethrum ear treatment has been in use for the control of earworms in sweetcorn, work has been in progress to find an easier but equally effective means of control. This paper discusses some of the newer organic insecticides and their possible use as controls for the earworms.

#### FIRST TEST

In the fall of 1946, 2 ear treatments, a 3 percent DDT dust and an oil + 0.2 percent pyrethrum injection were compared in

a 2 acres block of Ioana sweetcorn. The dust plots received 4 applications directly to the silk, the first when the silks were well out and before pollination had taken place, and the others at 3 day intervals. The oil series received only 1 treatment when silks had wilted. There was a very heavy infestation of the fall armyworm, *Laphygma frugiperda* (A. & S.) amounting to 95 percent of the total worm population. The remaining 5 percent were the corn earworm, *Heliothis armigera* (Hbn.). This is not the usual proportion of species, but both of these worms commonly attack corn in Florida.

The entire field was dusted 1 time for budworm, using 3 percent DDT distributed with a crank duster when the corn was 12

to 15 inches high. It received 2 subsequent applications of 3 percent DDT dust applied with a puff duster when the tassels were forming.

The DDT killed small instar larvae of the fall armyworm, but was ineffective against 5th instar and mature fall armyworms. In fact, mature larvae were rolled in the 3 percent DDT dust and they pupated and produced normal moths.

*Results.*—There was practically no difference between the oil and dust treatments in the percentage of marketable ears produced, or in the number of absolutely worm free. The percentage of marketable ears for the dust treated plots was 96.4 percent as compared to 94.5 percent for the oil treated silks. The percentage of worm free ears for the dust treated was 85.9 percent and 83.3 percent for the oil treated silks.

when oiled, the tip 1 inch to 1 1/2 inch was not filled.

#### SECOND TEST

Truckers hybrid sweetcorn was planted in the spring of 1947. A number of organic insecticidal sprays and dusts were compared with mineral oil + 0.2 percent pyrethrum. The data are given in Table 2. Practically all of the larvae attacking the ears in this test were the corn earworm, *Heliothis armigera* (Hbn.) All materials with the exception of mineral oil + 0.2 percent pyrethrum were applied 4 times at 3 day intervals. The oil + pyrethrum was applied once as an injection in the ear. All applications were directed on the ear. None of the materials affected the pollination of the ears.

*Results.*—So far as the number of marketable ears produced was concerned, the 3

TABLE 1

A COMPARISON OF 2 SILK TREATMENTS FOR THE CONTROL OF CORN EARWORMS

	No. of Marketable Ears			Percent Worm Free	Percent Marketable	Wt. of Marketable ears lbs.
	Slight damage, tip only	No Damage	Total			
DDT—3% Dust	215	1761	2046	85.9	96.4	914
Mineral oil & 0.2% pyrethrum	242	1803	2164	83.3	94.5	917

The biggest difference was in the number of worms entering the ears through the husks at the base or side of the ear (fall armyworms). There was much less damage to the dust treated ears, which is a rather important factor when we consider the number of ears discarded because of sideworms.

There was no difference in the size or weights of the ears from the 2 treatments. The weight of the dust treated ears was 914 pounds, and the oil-treated 917 pounds.

However, dust-treated ears filled completely to the tip, indicating no damage from the treatment. Oil-treated ears which received the application at the proper time filled to the tips; if the silk was immature

percent DDT dust and 3 percent Methoxy DDT dust were outstanding even though the 3 percent DDT just missed being significantly better than the oil + pyrethrum. The highest percentage of worm-free ears was for the mineral oil + pyrethrum, Methoxy DDT 3 percent dust and DDT 3 percent dust. The percentage of sideworm injury was greatly reduced with the DDT and Methoxy DDT dust.

Of the materials tested Methoxy DDT was outstanding as a budworm control. Dusts were more effective than sprays.

#### CONCLUSIONS

DDT 3 percent dust and methoxy DDT 3 percent dust are good controls for the

corn earworm. DDT is not effective against the fall armyworm whereas methoxy DDT is. Since methoxy DDT is so effective as a budworm control when applied as a dust to leaf whorls, it should be considered as a control measure for those worms (corn earworm and fall armyworm) attacking sweet corn. A dust program of 4 applications spaced 3 days apart starting at the time the silks emerge should produce a high percentage of marketable ears.

Sprays were less effective than dusts of the same material.

Since these must be direct applications to the silk of the ears, airplane dusting is generally ineffective. Drifting of dust has proven of little value commercially.

As a final precaution, the Bureau of Entomology and Plant Quarantine still considers crop remains dusted with DDT unsafe to feed to livestock. This is true for the other organic materials. In this connection, the Bureau is guided in its policy by the findings of the pharmacologists, toxicologists, and workers in related fields.

TABLE 2

THE CONTROL OF EARWORMS\* BY THE USE OF ORGANIC INSECTICIDES

Treatment	Source	Percent Marketable	Percent Worm Free	Percent free of Sideworm Infestation
1. Check		13.9	10.7	67.8
2. Mineral oil + 0.2% pyrethrin	John Powell	52.1	43.4	79.4
3. Syndet 1-400 Spray	U S. Rubber	44.0	11.9	87.0
4. Chlordane 50W 2 lb-100 spray	Velsicol	28.3	9.4	74.6
5. DDT 50W 3lb-100 spray	Dupont	43.0	20.4	85.0
6. Piperonyl butoxide 1-800 spray	Dodge & Olcott	19.7	4.1	75.0
7. Piperonyl cyclohexenone 1-800 spray	Dodge & Olcott	11.8	2.1	67.8
8. DDT 3% dust	Dupont	65.6	38.5	93.8
9. Chlordane 5% dust	Dow	34.4	10.0	88.2
10. Methoxy DDT 3% dust	Dupont	66.3	40.2	94.6
11. Methoxy DDT 2 lb.-100 spray	Dupont	27.1	8.6	74.1
12. Toxaphene 10% dust	Hercules	47.3	25.2	96.9
Difference necessary for significance		13.7	12.9	12.4

\**Heliothis armigera* (Hbn.)



# NEW FUNGICIDES

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Control of the major diseases which attack vegetables in Florida is essential for the profitable production of truck crops. Disease control should begin with the seed and continue until harvest. Good farming methods essential to the production of good crops are an aid in disease control. Use of disease free seed and disease resistant varieties when obtainable, chemical seed treatment to prevent seed decay and pre-emergence damping-off (8) and prompt plowing under of diseased crop refuse at the end of the harvesting season are practices which will help prevent maximum losses from diseases.

Post-emergency damping-off of seedlings in plant beds (9) and foliage disease of vegetables are the most difficult to control. More time and money are spent in combatting foliage diseases than any others. Their control consists of keeping the leaves, branches, and stems of the plants coated with fungicides which are applied as sprays or dusts.

## CONTROL OF DISEASES OF VEGETABLES WITH NEW FUNGICIDES

Within the last few years many new chemical compounds have become available for testing for the control of diseases, and some have given good control of various diseases at different stations throughout the United States. Results of testing some of the new compounds on vegetables in Florida have been reported in the Proceedings of the Florida State Horticultural Society (1, 3, 4) and other publications (2, 5, 6, 7).

Experiments conducted at the Vegetable

Crops Laboratory (4) and the Sub-Tropical Station (3, 5, 6, 7) have demonstrated that Dithane-zinc sulfate-lime, Parzate, Dithane Z 78 and Phygon-zinc sulfate-lime sprays are superior fungicides for control of late blight and early blight of potatoes and tomatoes.

New chemicals are being tested at different testing stations in Florida as soon as they become available. For example, during the last 7 years, 35 different formulations of sprays and dusts made of 17 different fungicides have been tested for control of downy mildew of cabbage in plant beds at the Potato Investigations Laboratory. Results of tests conducted in 1946 are shown in Table 1. None of the fungicides tested thus far have proved as effective as Spergon for control of downy mildew, but the search for something better than Spergon will be continued.

It is necessary to test each fungicide to determine its effectiveness in controlling different diseases. The proper amount of the active ingredient needed in a spray or dust to control a disease without injuring the plants on which it is used must be worked out for each fungicide. The amount of spray or dust required to cover plants at different stages of growth, and the number of applications and frequency of treatment needed to control the disease also must be determined.

Combining an insecticide and a fungicide and applying them as a single spray or dust is desirable as that eliminates the expense of applying them separately. However, it is necessary to mix the materials properly, apply them to the plants and note their effectiveness in controlling the disease and insects which are attacking the crop before reaching final conclusions regarding their compatibility and use as an insecticide-fungicide.

TABLE 1.—CONTROL OF DOWNY MILDEW OF CABBAGE IN PLANT BEDS WITH DIFFERENT FUNGICIDES IN 1946\*

Treatment**	Plants***			Total Weight Grams
	Percent Foliage Killed by Mildew	Large	Small	Total
Spergon Wettable 4 lbs.-100 gals.	5	1,215	1,307	2,525
Spergon Dust containing 12% of active ingredient	5	1,238	1,510	2,748
Dithane D 14 2 qts.-zinc sulfate 1 lb.-lime 1/2 lb.-100 gals.	10	562	1,772	2,334
Parzate 1 1/2 lbs.-100 gals.	20	776	1,882	2,658
Dithane Z 78 dust, 6%	20	553	1,493	2,046
Manganese ethylene bisdithiocarbamate 1 1/2 lbs.-100 gals.	30	262	1,757	2,019
Check (None)	50	106	1,288	1,394

\*Seed planted 10/16; mildew appeared 10/28; plants pulled 11/20.

\*\*Made October 24, 28 and 30, and November 1, 4, 6, 8, 11, 13, 15, and 18.

\*\*\*Pulled from 25 feet of a 2-row plant bed.

TABLE 2—SOME NEW FUNGICIDES WHICH ARE BEING TESTED FOR CONTROL OF DISEASES OF VEGETABLES

Trade Name	Active Ingredient	Company
Carbide and Carbon 341A	2 heptadecyl-glyoxalidine	Carbide and Carbon Chem.
Carbide and Carbon 169	Zinc-copper-chromate	Carbide and Carbon Chem
Copper A Compound	Tetra copper calcium oxychloride (45% metallic Cu.)	Dupont
Dithane D 14	25% Disodium ethylene bisdithiocarbamate	Rohm and Haas
Dithane Z 78	65% Zinc ethylene bisdithiocarbamate	Rohm and Haas
Fernate	70% Ferric dimethyl-dithiocarbamate	DuPont
Karbam (Black)	70% Ferric dimethyl-dithiocarbamate	Sherwin-Williams
Karbam (White)	70% Zinc dimethyl-dithiocarbamate	Sherwin-Williams
Methasan	70% Zinc dimethyl-dithiocarbamate	Monsanto Chemical
Parzate	65% Zinc ethylene bisdithiocarbamate	DuPont
Phygon	87% 2, 3, dichlor-1, 4 naphthoquinone.	U. S. Rubber
Spargon	98% Tetrachloro-para-benzoquinone	U. S. Rubber
Spargon Wettable	48% Tetrachloro-para-benzoquinone	U. S. Rubber
Tersan (Thiosan)	50% Tetramethyl-thiuram-disulfide	DuPont-Semesan
Tribasic Copper Sulfate	Tribasic copper sulfate (53% metallic Cu.)	Tennessee Copper
Zerlate	70% Zinc dimethyl-dithiocarbamate	Dupont

A recent survey of the work in progress at the Florida Agricultural Experiment Stations show that one or more of the fungicides listed in Table 2 are being tested for control of the following diseases: *Alternaria* leaf spot, damping-off, downy mildew and wire stem of cabbage and other crucifers; downy mildew of cantaloupes, *Alternaria* leaf spot of carrots; *Cercospora* (early) blight, damping-off and *Septoria* blight of celery; downy mildew of cucumbers; *Alternaria* leaf spot of lettuce and escarole; *Alternaria* blight, bacterial blight and *Cercospora* leaf spot of peppers, late blight and early blight of potatoes; late blight, early blight, and *Stemphylium* spot of tomatoes; Anthracnose of strawberries, and downy mildew and anthracnose of watermelon.

Dithane D 14 is already being used extensively for control of late blight and early blight of potatoes and tomatoes. Parzate, Dithane Z 78 and Phygon probably will be used for control of the same diseases when supplies of these materials become more plentiful. Spergon is used generally for control of downy mildew of cabbage in plant beds.

Preliminary tests have shown that Zerlate may be useful for the control of several diseases. Information and recommendations

on the use of Zerlate and other new fungicides will be released as soon as repeated tests have demonstrated their effectiveness.

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# PRESENT STATUS OF THE MOSAIC DISEASE OF VEGETABLE CROPS IN SOUTH FLORIDA

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The farm lands along the Atlantic coast from West Palm Beach to Homestead constitute one of the largest winter vegetable sections in the United States. Practically all of the common vegetables are found in this area at some time during the season from October to May, varying from snap beans in early fall to peppers, squash, lima beans, and tomatoes in late spring. The approximate acreages of the most important crops are as follows: peppers 4,200; squash 3,500; eggplant 1,000; cucumbers 2,000; lima beans 3,000; snap beans 30,000; and tomatoes 11,000. Since harvests of these crops are made at a time when green vegetables are scarce in most parts of the country, the acre value in South Florida is usually high. Accordingly, any factor that influences yields is quickly reflected in the income of the individual farmer.

Florida vegetables have suffered heavy losses at various times from both fungus and bacterial diseases but only recently have some of the crops listed above shown serious infections by virus diseases. While diseases due to virus infections have been present to some extent each year on practically all crops, their importance when compared to other diseases has been considered only nominal. Since 1944, however, the increase in severity of all virus troubles in South Florida has been at an alarming rate, reaching a point at the present time when

the future of some crops is in doubt, unless resistant varieties can be developed. In order that this problem may be more clearly seen, a brief description of the most important diseases is given below:

*Snap Beans.* The common bean mosaic virus has been noted in all fields each season for the past three years, usually being somewhat more prevalent in early fall and late spring than during the mid-winter months. Until the season of 1946-47, most of the trouble was confined to the foliage, with only an occasional pod showing distortion or roughness. During this past season, however, many fields throughout the South Florida area became heavily infected, with both pods and foliage showing typical virus distortions. The condition became so serious during January and early February that prices of beans from some infected fields dropped almost 50% on local markets.

Inoculation studies showed that the cause of this outbreak was due to the common bean mosaic virus or some variant of this virus. Since these studies were only exploratory in nature and did not cover the entire field, it is possible that other viruses may have been involved. Due to the fact that the common bean mosaic and its related strains are seed-borne, it may be assumed that the initial infection concerned in the present case was introduced in the seed. Much of the secondary spread may have resulted from aphid infestation, as this insect was present in most fields during the season. Previous studies have shown that most species of aphids are capable of transmitting the virus. Another possible contributing factor, especially in the detection of symptoms, may have been the unusually high daily mean temperatures during the months of October through January. Mo-

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saic is difficult to diagnose under certain weather conditions but weather has little effect on its presence. Low temperatures mask symptoms of mosaic whereas reasonably high temperatures favor their appearance. Comparative data show that temperatures during this period were approximately 10° F. higher than the long time average for these months.

*Peppers.* When considered from a monetary viewpoint, peppers have suffered much greater losses during the past three years than beans. Most peppers in South Florida are started in seed beds, then transplanted by hand to the fields. This method of handling subjects the plants to considerable bruising and may contribute appreciably to the spread of the virus diseases. In addition to this, aphid infestation is very heavy at times and spread by aphids is probably the most important factor in the spread of the disease.

Virus leaf mottling appears in most cases on peppers soon after the plants are transplanted. As the plants increase in size new leaves become infected and, finally, the fruits themselves. In the latter case the fruits become knotty, irregular in size, and poor in color. Seldom do fruits reach normal size, thus yields are reduced both in quantity and in grade.

During the past year pepper fields began showing severe mosaic symptoms by early November and continued to do so throughout the entire season. Many fields failed to yield sufficient fruit to pay cost of production while others showed heavy losses in grade. At no time during the season were there full shipments of top grade peppers from South Florida and most of this can be attributed to mosaic infection.

The principal cause of pepper mosaic in this section of the state is very probably cucumber virus 1, although other viruses may be involved also. This particular virus is known to attack a wide range of wild host plants, many of which are found along local canal and ditch banks, thus opportunity is afforded at all times for spread of the

virus to pepper fields by aphids. Little attempt has been made in recent years to kill out wild hosts around cultivated fields so the present serious condition may be the result of this neglect.

*Squash.* The growing of squash in the Pompano area of Broward County has been curtailed to a considerable extent during the past three years as a result of heavy mosaic losses. Many growers have either quit growing this crop or else have moved to other sections where "new" land may be had, experience having shown that repeated plantings on the same land results eventually in total loss of the crop. While the Pompano section has suffered the greatest losses from mosaic, there is no section along the lower Florida east coast that is free of this trouble.

As in the case of peppers, squash plants usually show infection in the early stages of growth, although the heaviest damage occurs immediately before and during the harvest period. The leaves show mottled or savoyed areas, also dark green and yellow blotches. In some cases, blossoms fall before fruits are set and infected fruits that remain on the plants show mottled areas which make them unfit for market. It is not uncommon to see more than 50% of the fruits from an infected field discarded on account of mosaic infection. In many cases entire fields are abandoned by the time of the first harvest.

The principal virus connected with squash mosaic appears to be cucumber virus 1. Since this virus is not believed to be seed-borne, we may assume that it persists on wild host plants in or near cultivated fields. Several different insects are capable of transmitting the disease from one plant to another, but it is probable that aphids are largely responsible for the present widespread infection in South Florida. In this connection it is of interest to note that losses have been particularly severe during warm periods when insect infestation was high.

*Cucumbers.* Although cucumbers are not

grown in South Florida on a large scale, the per acre returns are usually fairly high, consequently any appreciable reduction in yield becomes of considerable importance to the individual farmer. While diseases such as downy mildew and bacterial wilt are serious at times, mosaic is becoming more of a limiting factor in production each year. All fields show some loss from this disease and many yield less than half a crop. Much as in the case of squash, it is no longer safe to grow cucumbers on old lands in this section.

Mosaic may attack cucumbers at any time. The young leaves become dwarfed, cupped, densely clustered, and dark green. Old leaves turn yellow and the fruits become dwarfed and malformed. This results in reduced yields in the fields and very heavy losses in the packing sheds due to grading out fruits that fail to meet grading standards.

Cucumber mosaic is caused by one or more strains of cucumber virus 1. As in the case of peppers and squash, this disease lives over from one year to another on wild host plants and can be spread from these to the cucumbers by insects. Aphids are particularly bad on this crop and aphid transmission is probably the most important factor in disease spread. The elimination of weeds around the fields appears to be the first step in control. After this, a rigid attack on insect infestation, particularly the aphids.

*Tomatoes.* Virus diseases have been present on tomatoes in South Florida for many years but have not been of serious concern to the average grower due to the fact that good yields have been had in most cases in spite of widespread infections. In recent years, however, losses due to mosaic have become fairly common and in some instances quite serious. As in the case of other vegetable crops, mosaic may attack tomatoes in this area at any stage of growth. Some fields have been observed where most of the plants showed infection shortly after transplanting while others showed symptoms

at any time from date of first bloom to last harvest.

There are a number of different viruses that attack tomatoes but the two most common in South Florida are cucumber virus 1. and tobacco virus 1. Very likely, there are others present also, since host plants of some of these forms are common over much of the territory. The symptoms usually noticed first in commercial fields are spindled, spirally twisted, curved or filiform young leaves with older leaves becoming chlorotic and often rolled or folded. These are the typical symptoms of cucumber virus 1. In other cases the plants may be normal or stunted but with the leaves showing bright mottled patterns with raised green areas. Some foliage may show a fern-leaf distortion or may be otherwise reduced in size. These are symptoms of tobacco virus 1. Regardless of the virus concerned, infected plants suffer from reduced leaf area and impaired chlorophyll activity, both of which influences yields and quality of fruits.

As in the case of peppers, much of the tomato acreage in South Florida is set with plants from seed beds. The amount of bruising that results from this method of planting could account for a considerable amount of disease spread. Insects, particularly aphids, may also play an important role in disease dissemination during certain periods of the winter season.

In most cases tomato mosaic gains entrance to both seed beds and cultivated fields through the medium of wild host plants. There are few if any fields in South Florida which are free of all weeds capable of harboring one or more of the tomato viruses, consequently the possibility of infection from these sources is present at all times. While better insect control and a general clean-up of ditch and canal banks would probably not completely control the mosaic troubles on tomatoes, this practice would very likely reduce to a considerable degree the severe losses that are being experienced in some sections of the lower Florida east coast.

*Wild hosts.* There are many weeds in South Florida which harbor viruses of various kinds. These grow in profusion along canal and ditch banks and provide a constant source of inoculum for several of the cultivated crops. That these weeds play an important part in the present serious condition can not be doubted, however, the identity of the respective viruses on these wild host plants is not well known and until a

thorough study of them is made a sound program of control can not be recommended. During the past year, the Everglades Experiment Station at Belle Glade has instituted studies on the problem and out of this should come a better understanding of the disease complex and a logical approach to the commercial control of all mosaic troubles in South Florida.

## CONTROL OF CELERY DISEASES

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One of the tests given to inmates of insane asylums to determine their eligibility for release is to give them a mop and let them into a room containing a wash basin running over the brim. If the patient begins to mop the floor before he turns off the faucet he stays. For at least sixty years farmers and experiment station workers have been mopping celery diseases frantically while the basic sources continue to flow unheeded.

We spend approximately a quarter of a million dollars in Florida annually for chemicals, and a lot more for labor and equipment in attempts to control our number one celery disease, *Cercospora* blight. A substantial portion of state appropriations are spent finding out which chemical to use, how many pounds to add to 100 gallons, how many gallons to spray on an acre, what supplements to mix with it, how often to apply it, proper pressure, orifice size, nozzles per row and a dozen other technical angles.

At first we were exploring the use of copper compounds. Bulletin 366 published in 1942 summarizes results of eleven years work by Townsend of the Belle Glade station on the use of copper-containing mate-

rials. Now the trend is toward organic materials, particularly the carbamates. At Sanford we like a mixture of iron and zinc dimethyl carbamates, now being marketed in 70 percent active powders as Fermate, Zerlate and Karbam. We find that one pound each of the iron and zinc salts in 100 gallons of water, applied weekly at the rate of 125 gallons per acre, controls blight. The sprayer should operate at 300 pounds pressure and have at least three nozzles per row.

Although we like this mixture best there are other materials that will control blight. The sodium ethylene carbamate marketed as Dithane D14, the zinc ethylene carbamate sold as Dithane Z 78 or Parzate, and the quinone marketed as Phygon have all been reported as effective. Many of the old copper compounds still do a good job when properly applied.

The working out of a satisfactory spray program is important but even the best spray program is only an emergency measure to save the celery crop until a more basic solution can be found. Growers want an immediate solution of their problem and fungicide sprays are rapid. Also it is easy to set up a spray experiment, for a dozen chemical manufacturers are willing and eager to furnish samples for test. But pathologists would be doing a serious disservice if they allowed pressure from either short sighted growers or aggressive mer-



chants to deter them from searching for a more permanent and economically sound means of eliminating loss.

A few years ago Townsend of Belle Glade and Emerson of Cornell began work on a program of breeding blight resistant celery. The parents from which they obtained resistance had hollow petioles, a sprawling habit, pink coloring, and a strong flavor. It took several years of crossing to bring blight resistance into a strain that approached commercial celery in quality. The program has been delayed by lack of facilities for producing seed and by restrictions against out of state travel but it is making definite progress. There will be tests at Sanford and Belle Glade this year of some sixty selections. A little more work will be needed to get strains ready for release, but it is possible to have on the market within three years strains of both green and golden celery which will not need fungicidal sprays. If this project can be completed it will be of more importance to Florida celery growers than all the spray tests of the past sixty years.

Another celery disease on which a lot of emergency experiments have been performed is damping-off. We plant our celery seed on saturated soil in beds surrounded by water, covered by cloths which restrict air movement, during seasons when the temperature is often above ninety and when rains occur almost every day. It would be difficult to produce conditions more favorable for development of fungus diseases. Growers often sow three times the number of beds they expect to need in hopes that enough plants will survive. With this disease as with blight the most obvious and immediate solution is to apply chemicals. Formaldehyde or chlorpicrin applied to the soil before planting reduce but do not eliminate damping-off. The cost has been so high that most growers do not practice the treatment. Seed treatments also help in some cases but they are not adequate for the severe conditions under which our celery plants are grown. Sprays or drenches are

therefore necessary as supplements to the soil and seed treatments. We have found one of the carbamates marketed as Tersan to be the most effective in our tests at Sanford. It has the disadvantage of being injurious if used in excess. A weekly treatment using 1 pound to the 100 gallons and no more than 20 gallons to a 1200 square foot bed has given good control. It should not be applied less than 2 weeks after seeding. A quinone, sold as Spergon, has been used extensively for this purpose. At 4 pounds per 100 gallons it is less injurious than Tersan, but in our tests not as effective a fungicide. The iron carbamate, Fer-mate, used as a dust for blue mold control in the tobacco area has also given protection from damping-off.

With damping-off as with blight we have concentrated on emergency treatments of the mopping up category by necessity. But with this disease also there are more basic solutions in sight. Tisdale at Gainesville and Brooks at Plant City investigated the effect of soil organic matter on damping-off. Their results plus those of workers in other states suggest that a fundamental solution of the damping-off problem might be found by establishing conditions in the soil under which organisms which antagonize the pathogen will thrive. We have no end in sight on this approach, but there are enough encouraging leads to make further investigations well worth while. It is quite within the realm of possibility to use the common soil organism, *Trichoderma*, to antagonize the plant pathogenic *Rhizoctonia* just as medical men have used the mold, *Penicillium*, to antagonize human pathogens.

A third disease of celery, *Septoria* blight, is less common in Florida than it is elsewhere. It may be distinguished from *Cercospora* blight by the presence of minute black fruiting bodies appearing as dots on the surface of the lesions. Spray programs for this have also been devised but a more basic solution is readily available. The organism apparently does not survive in Florida soils so that the only means of in-

roducing it is with infected seed. Fruiting bodies of the fungus, *Septoria*, appearing as black bumps on the surface of the seed make detection of infected seed lots easy. The fungus does not sporulate at high temperatures so that our only concern need be with the late crop sown in November and December. Seeds planted in this period should be examined and if *Septoria pycnidia* are present should be dipped in water at 118°F. for 30 minutes. Seed which is two or more years old contains no viable *Septoria* spores. We are fortunate to have so simple a means available for the solution of a problem which is much more complicated in other celery growing areas.

Mosaic is a fourth disease which in some areas has become serious. The most common type produces mottled leaves and stunted plants and most serious of all elongate brown lesions on the petioles. There is no chemical spray or dust which controls mosaic virus because the infective agent is within the plant. The disease lives through the summer on weeds and is spread from plant to plant by aphids. At present control must be through the use of herbicides to keep all areas near the seedbeds free of weeds and of insecticides to control aphids. There is some reason to think that some of the blight resistant celery strains may also be resistant to mosaic but further work is necessary to prove it.

Nematode injury is frequently classed as a disease. The root knot nematode which produces swellings on the roots and the meadow nematode which chews off the fine roots are both pests of celery. Within the past few years cheap fumigants have been introduced which make it possible for growers to reduce the nematode population of their seedbeds and even their entire fields at a cost of less than fifty dollars per acre. Ethylene dibromide injected into the soil, at 15 gallons of 20 percent solution by volume per acre, has been the most satisfactory material in our trials. Dichlor propene injected at 20 gallons of 50 percent mixture is also satisfactory as a nematocide, but it

is corrosive and remains in the soil longer than ethylene dibromide. Florida can expect some new approaches to the nematode problem when Christie, nematologist of the federal department of agriculture, begins his work here.

Another disease of celery which appears in some seasons is pink rot. It is caused by the soil inhabiting fungus, *Sclerotinia sclerotiorum*, which attacks mature plants at the base and destroys them. Its outbreaks have been sporadic, often following injury by cold, blight, or spray material. Dr. Brooks studied the disease at some length and published his results in press bulletin 567. He recommends the use of 800 to 2000 pounds of calcium cyanamid stirred into the soil five weeks before setting plants. Flooding the soil for four weeks is another possible control.

There are a number of other celery diseases which sometimes cause loss. Bacterial blight produces leaf spots which can be distinguished from *Cercospora* by the absence of mold and from *Septoria* by the absence of pycnidia. It is controlled by soil rotation and by the same sprays which are used against *Cercospora*. Yellows is a fungus disease caused by *Fusarium* growing in the water vessels of the plant. It stunts and yellows the plant. Resistant varieties of celery must be used where this is present. Phoma rot causes a rotting at the base similar to pink rot except that pycnidia are present in the rotted areas. It is a cool weather fungus for which no control is known.

In addition to the infectious diseases mentioned there are a number of physiological disturbances often found in celery fields. Black heart is the most serious of these because its appearance is unpredictable and no control is known. Crack stem caused by boron deficiency is rarely a problem today because of the easy control method of applying 10 pounds of borax per acre. Pencil stripe, which appeared a year ago, appears to be related to borax supply also. There are a number of other nutrient deficiency

symptoms which are outside the scope of this paper.

In presenting a general paper of this sort it is easy to multiply specific recommendations for control of the various diseases and to lose sight of the general principles of disease control which underlie the recommendations. In approaching a disease problem the cheapest, most efficient solution is to find a crop variety which is immune or resistant. Our breeding program on celery is therefore the most valuable of all our celery disease projects. If no plants resistant to a disease are available the use of some organism which will permanently parasitize the pathogen is another basic and satisfactory approach. Attempts to control damping-off by antagonists are examples. A

somewhat less satisfactory approach is to exclude the pathogen by artificial means. Seed treatment for Septoria and weed and aphid control for mosaic are examples.

In dealing with a disease which lives in the soil, and where resistant strains are unknown, a fourth approach, eradication, is possible. Flooding or treating with cyanamid for pink rot control, and fumigating for damping-off and nematode control come to mind.

When time is short and ideas are few we will continue to grab for the mop instead of the faucet. But protective sprays are expensive and they should always be looked upon as either a last resort or a source of emergency relief.

## VALUE OF RAPID SOIL TESTS IN DETERMINING FERTILIZER NEEDS

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During the last 10 years agronomists and soil chemists have contributed much to the development of rapid chemical tests as a means of determining the fertilizer needs of the soil. These many contributions have shown that no method has yet been devised that is infallible. This has led some workers to question the chemical accuracy and the reliability of the results of such soil tests, despite the fact that many commercial organizations and several state experiment stations are making thousands of rapid soil tests each year. The chief advantages of these rapid tests over the older and more conventional chemical methods are their simplicity and the rapidity with which the individual tests can be carried out. These features make them well suited for routine soil testing.

There is a tendency on the part of some workers to expect too much of the rapid soil tests and to criticize them when they fail to come up to expectations. It is not reasonable to think that soil tests, in all cases, should correlate directly with the crop responses obtained from the use of fertilizers. There are various reasons for this lack of correlation but the principal one is the failure for the most part to adapt a set of methods suitable for the soils and crops under investigation. It should be obvious that the results of chemical soil tests provide only a part of the information necessary for an intelligent fertilizer recommendation. When properly correlated with crop responses to fertilizers on different soils, chemical soil tests can furnish valuable and otherwise unobtainable information that can serve a very useful purpose in fertilizer recommendations. This is true only when the tests can be relied upon to give consistently accurate and reliable analytical results.

Let us now consider some of the pecu-

liarities involved in soil analysis. It is of the utmost importance that the sample of soil to be analyzed should be representative of the area sampled. If the soil type is relatively uniform, one sample consisting of borings made throughout the area is usually sufficient. If the soil type varies within the field, more samples should be taken corresponding to the soil variations. One of the greatest needs in soil testing in Florida is a practical method of obtaining a representative sample from a field that has been bedded and side-dressed. One method now in use is to make a cut 6 inches deep across the entire bed, and then scrape soil from the exposed surface. This soil is mixed thoroughly and a representative sample taken for testing. This method is laborious and often unreliable, especially if the soil is dry. We have recently made a soil sampler which takes a sample 12 inches by 1 inch to any depth desired. By taking 2 or 3 slices with such an implement the operator should be able to obtain a sample representative of the cross section of the bed. We have had this sample only a month or two but so far it has worked very satisfactorily. It is more time consuming than the ordinary sampling tube, but it does give a more representative sample.

With the soil sample now taken, where should it be tested: at a state-wide soil testing laboratory such as at the State Agricultural Experiment Station, at a district laboratory, or by the grower himself? Without doubt the best job of testing could be done at a central well-equipped laboratory but under such a system at least a week would elapse from the time the sample was taken until the grower could be notified as to the analysis. This would not be a factor in many states but in Florida, especially on the sandy soils, the situation is somewhat different. Here the grower may be interested in how much nutrient has been lost by leaching following a heavy rain and whether or not he should apply a side-dressing. Under such conditions time is of the essence and the grower ought to have the analysis within

2 or 3 days at the latest. Without doubt a district laboratory could render the service in the shortest possible time.

Now as to methods of analysis. There is little doubt that a district laboratory, no matter how small, can do an adequate job of analysis, if properly organized and equipped. When such a laboratory is not available, the grower must either do his own testing or rely on trial and error.

There are several soil kits, now available on the market, for the grower who wants to test his own soils. These range in price from \$10.00 to more than \$65.00. These kits are so designed that they can be used by persons without scientific training and with a minimum of laboratory facilities. They also contain directions for their operation and for an interpretation of the results. At present the grower is at a loss as to which soil kit to buy. Each year numerous requests are received for an opinion regarding the reliability of soil kits for diagnosing the fertility of a soil. At the Vegetable Crops Laboratory we are now carrying out experiments on the relative accuracy, sensitivity, reliability and ease of manipulation of 6 soil kits in the estimation of soil fertility in the critical range of growth response with vegetable crop plants. It is particularly desirable to know how results obtained by the use of these various outfits compare with one another and how they are correlated with plant growth on different soils under various conditions.

All of the 6 kits now being compared employ extracting solutions in some manner. These kits have been adapted from methods worked out by various state agricultural experiment stations and applied to the soils of their respective states. In some cases the published methods have been commercialized and the composition of all reagents are known. In other cases the information furnished with commercial sets gives no clue as to the chemical composition of the various materials used for the tests. The company expects to furnish refills as a part of its business. Nearly all laboratories of

course prefer a system which allows them to make up their own reagents from stock chemicals because many of the refills are quite expensive. The Hellige kit is based in part on methods used at the Wisconsin Agricultural Experiment Station. The La Motte kit is based partly on Wisconsin methods and partly on those used at the Connecticut Station. The Simplex set is manufactured according to directions published by the Michigan Station. The Urbana Laboratories in their set use the directions of the Illinois Station and the Purdue set was developed by the Purdue Station. No information could be obtained regarding the reagents used in the Sudbury kit.

As already mentioned, most of these kits have been adapted from procedures worked out by different experiment stations for use on soil types in their particular states. For this reason, they may or may not be suitable for the soil types present in Florida. It therefore stands to reason that kits adapted to flatwood soils may not be reliable on the muck of the Everglades or on the marl soils in the Homestead area. At the Vegetable Crops Laboratory we are trying to ascertain which of the above-mentioned kits can be used with confidence on the sandy flatwood soils.

We have considered the sampling and analysis phases of soil testing, but the phase dealing with interpretation of results is usually subjected to the most serious inaccuracies. These errors arise because this interpretation should be based on a consideration not only of the chemical analysis, but also of nutrient balance, crop requirement, soil type, texture, drainage, method of irrigation and seasonal rainfall and temperature. All of these factors play an important role in the nutrient uptake by the plant and must be considered before a satisfactory recommendation can be made. For example: the nitrogen level may be adequate but if potassium or any other of the essential nutrient elements is deficient, poor growth will result. Furthermore, it is well known

that crops vary considerably, not only in the total amount of nutrients required but also in their requirement at different periods of growth. Every one knows that more fertilizer is required during a period of heavy rainfall than during a dry spell. In a dry soil ammonia is readily converted to nitrates but in a wet soil the reverse may take place. These few examples will serve to show the importance of these environmental and cultural factors in interpreting soil analysis data.

There are many instances when a simple pH determination will go a long way in diagnosing soil disorders and save the time and trouble involved in making a complete soil analysis. Such a pH determination can be made by most County Agents. Soil reaction in itself is not a measure of soil fertility but it does indicate whether or not the soil is in condition to allow the most efficient utilization of fertilizer. In highly acid soils leaching of potassium, ammonia nitrogen, magnesium and calcium is much more severe than in slightly acid or neutral soils. This is especially true in flatwood sands low in organic matter. Moreover, the availability of certain minor elements such as copper, boron, manganese and zinc for most crops is decreased if the soil becomes too alkaline. Physiological studies have shown that ammoniacal nitrogen can be readily assimilated by some plants if the soil pH is near the neutral point. This fact is well worth considering now that most of our commercial fertilizers contain from 75 to 90 percent of their soluble nitrogen as ammoniacal nitrogen. Recent studies indicate that incidence of blossom-end rot on tomato may be closely tied up with ammoniacal nitrogen and pH.

All too frequently soil samples are received with a request for a complete chemical analysis. Not only is such an analysis a complete waste of time but an interpretation based on such an analysis is next to impossible. If a soil analysis is desired to corroborate a field diagnosis of poor plant growth, a soil sample from around a normal

plant in the same field should be submitted. From a comparison of the analysis of these 2 samples, the worker is in a better position to make a sound interpretation of the analytical data.

In most states rapid soil tests have been used as a prevention rather than as a cure. Because of our local conditions in Florida rapid soil tests may play an important role in "trouble shooting." For example, an experienced grower may recognize a certain growth abnormality and attribute it to be a nutrient deficiency. A rapid soil test carried out at this time may corroborate his diagnosis and permit him to take steps to correct the condition before the crop becomes a total loss.

The rapid tests have not been too satisfactory in diagnosing trace element deficiencies. However, by ascertaining the pH of the soil, an experienced worker can usually diagnose minor element disorders. For example, on a recently limed sandy soil, a deficiency of manganese is apt to occur.

It is believed that soil testing and recommendations based upon sound principles are true aids to the grower. However, there are certain limitations which should be borne in mind. First, plant roots absorb elements from the soil slowly while in soil tests the solvents are in contact with the

soil materials only a few minutes. Second, the roots of different plants vary in the amount of nutrient they can absorb. Soil tests are designed for general crops and must be carefully standardized for particular crops and particular kinds of soil. Moreover, plants feed out of the subsoil as well as out of the upper 6 inches; thus soil samples do not represent the entire environment. Plants absorb elements out of the whole soil complex, part of which may be alkaline (subsoil) and part acid (surface soil).

In conclusion may I repeat that there is no doubt about the value of rapid soil tests to growers where they have been extensively used by trained workers. Such states as New Jersey, Wisconsin, Virginia, North Carolina, Indiana and undoubtedly several others have used them with good results. The basis for this successful usage is that in these laboratories the tests are made and interpreted by agriculturists who have had broad experience with the group of soils being tested and the nutritional requirements of the crops normally grown. Our immediate problem here in Florida is to acquaint ourselves with the crop responses obtained by fertilizer applications on the many soil types found in the agricultural areas.

# EFFECT OF SOIL ON THE MINERAL COMPOSITION OF COMMERCIALY GROWN VEGETABLES

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Soil composition is usually the most important of the environmental factors causing variation in mineral composition of plants, with climate and season of secondary but still significant effect. The latter may possibly have a relatively greater importance in influencing organic composition under Florida conditions (1). Plant analysis has been most frequently used in the past for the purpose of increasing crop production. Such data do not represent the composition of the products found on the market. For this reason more emphasis should be placed on the composition of the products produced under commercial practices.

It was the purpose of this work to determine the ranges in mineral composition of severally commercially grown vegetables in Florida, and to correlate the composition with cultural practice, locality, soil type and soil composition. A detailed report of the data appears elsewhere (2).

Four categories of vegetables, based on the edible portions, were sampled. Cabbage and collards represented leaf-type vegetables; snap beans the pod-type; tomatoes, the fruit-type; and celery, the stem-type. Vegetables were collected from each area as near the peak of the harvest season as possible. An average of 8.6 samples were collected from each of the major areas. Only marketable samples were collected. The fields selected for sampling were chosen in a manner intended to make the data representative of the area. Crop and soil samples were taken across the rows in a line usually extended from 100 to 200 feet de-

pending on the size of the field. Soil samples consisted of 20 plugs, 6 inches deep, taken at random. Twenty-four heads or stalks of cabbage, collards or celery; or about 10 pounds of beans or tomatoes were taken from a field.

All samples were thoroughly washed with distilled water, using a bristle brush to remove foreign matter. Cabbage heads were divided to make 2 samples, one consisting of the 6 to 8 green leaves next to the head, and the other consisting of the head, itself. Collards were prepared by stripping the thin portion of the leaves from the coarse portion of the petiole and making a sample of each portion. Celery stalks were first topped near the center of the leaf cluster, followed by cutting the roots off as close as possible without causing the stalk to fall apart. The oldest outer stems were also discarded. Beans were prepared by removing the calyx from the stem end. Tomatoes were washed and halved for drying.

All samples were dried at 70°C., and ground in a Wiley mill for macro analysis and in a porcelain mortar for the determination of iron. All chemical analyses of plant materials and soils were made by standard quantitative procedures, and reported on the oven-dry basis. Plant materials were reduced by wet combustion with perchloric acid for all analyses except iron.

## PLANT COMPOSITION

A statistical analysis of variance was made of the plant composition data in order to have a basis of evaluation of the variations noted between areas. Only those differences showing a significance at odds of 19 to 1 or greater will be mentioned. Analyses of individual areas are considered as

above or below average for the state if they are significantly above or below the general average for the crop in question as found by this investigation.

### *Cabbage*

Analyses of cabbage heads showed significant differences in protein, calcium, magnesium and iron percentages between areas. It was found that the average for the Belle Glade area was above the general average of all areas in protein, calcium, magnesium and iron; while samples from the Bradenton area were below the average in protein and iron; and samples from Winter Garden, below average in iron.

Analyses of cabbage leaves showed significant differences in protein, calcium, magnesium, potassium, phosphorus and iron percentages between areas. Samples from Belle Glade were above average in protein, calcium, magnesium and phosphorus; while those from Hastings were above average in potassium and phosphorus; and those from Bradenton, below average in protein and phosphorus.

### *Beans*

The composition of 25 bean samples collected from the vicinities of Belle Glade, Homestead, and the lower east coast section of Palm Beach County showed significant differences in protein, calcium and phosphorus percentages between areas. Samples from the Belle Glade area were above average in protein but below average in phosphorus; while samples from the Homestead area were above average in phosphorus; and samples from the Palm Beach area, below average in calcium.

### *Celery*

The composition of 27 celery samples collected from the vicinities of Belle Glade, Sanford and Sarasota showed significant differences in calcium, potassium and phosphorus percentages between areas. Samples from the Belle Glade area were above average in potassium. Those from the Sarasota area were below average in calcium but above average in phosphorus.

### *Tomatoes*

The composition of 43 tomato samples collected from Homestead, Ft. Myers, Ft. Pierce and Collier County areas showed significant differences in protein, calcium, potassium and phosphorus percentages between areas. Samples from Homestead Rockdale soils and Perrine marl soils were above average in calcium, while those from Ft. Pierce and Ft. Myers areas were below average in calcium. Samples from the Ft. Pierce area were above average in phosphorus, but those from Collier County below average in phosphorus.

### EFFECTS OF SOILS ON PLANT COMPOSITION

Certain differences in plant composition appear to be attributable to major soil characteristics. Differential response of plant varieties is not considered in this report because they appear to be of minor importance.

Moderate differences in fertilization within the same vegetable producing area on similar soil types did not appear to consistently influence plant composition. There was some indication that differences in practices between areas may have been a factor. Cabbage grown in the Hastings area received relatively more potassium in the fertilizer, and the crop was found to be relatively high in this constituent. Soil types were found to have considerable effect, but the chemical composition of the soil did not always correlate with plant analyses.

The differences in exchangeable bases and weak acid soluble phosphorus in the soils at the time of harvest appeared to be due more to soil type characteristics than to residual accumulation from differences in fertilization. Relatively higher potash concentration in the Perrine marl soils under tomato culture as compared to bean culture, indicated differential residual effect of different treatment on a given soil. There is also some indication of similar residual effect on the organic soils of the Belle Glade area.



The organic soils of the Belle Glade area contained large quantities of organic nitrogen, exchangeable or ammonium acetate soluble calcium and magnesium. This was reflected in the composition of cabbage. However, these soils were relatively low in dilute acid soluble phosphorus and exchangeable potassium, but produced cabbage which averaged second highest in these 2 elements. A higher level of organic matter apparently favored the availability of phosphorus and iron, and possibly potassium. Cabbage containing the lowest concentration of phosphorus was grown on mineral soils in the Bradenton area which contained a relatively high amount of soluble phosphorus. Potassium followed the same trend in that it was relatively high in the soils of the Bradenton area yet the cabbage was below average in potassium.

The composition of green beans did not vary as much as the composition of cabbage, although the soil types on which beans were grown represented a wider range in chemical composition. Seed bearing portions of plants are known to be more constant in composition than leaves.

The calcium and magnesium content of beans was definitely associated with soil type. Calcium was highest in beans grown on the Perrine marl soils at Homestead and second highest in those grown on the organic soils of the Belle Glade area which also contained large quantities of calcium. The highest average concentration of phosphorus was found in beans grown on calcareous soils. These soils were low in dilute acid soluble phosphorus content but measured relatively high in carbonic acid soluble phosphorus. The latter measure is the more reliable for calcareous soils. The pH of the calcareous soils was above neutral but the organic matter content of these soils was relatively high and probably aided in phosphorus assimilation by the plants. On the other hand, phosphorus was low in samples from the organic soils of the Belle Glade area, which was the reverse of the findings with respect to cabbage.

The iron concentration in beans averaged highest for those grown on acid organic soils, was next highest in beans grown on mildly acid sands and generally low in those grown on calcareous soils. This is in agreement with other investigations on calcareous soils.

There appeared to be a correlation within each area between potassium in the beans and that found in the soil. It also appears that, in organic soils, potassium was retained best in those containing the most calcium, regardless of pH or exchange capacity. Volk and Bell (<sup>3</sup>) have shown that nitrates preferentially move as  $\text{Ca}(\text{NO}_3)_2$  with attendant depression of the solubility of potassium in the soil.

The analyses of celery samples and the corresponding soils showed that celery grown on the organic soils of the Sarasota area contained far less calcium and more phosphorus than celery grown on mineral soils at Sanford or the organic soils of the Belle Glade area, yet the soils of the Sarasota area were high in exchangeable calcium and soluble phosphorus. The phosphorus levels in the Belle Glade area soils were low, which apparently correlated with low phosphorus content in the celery as was found for beans, but in contrast to cabbage.

The potassium of celery grown on the organic soils of the Belle Glade area was exceptionally high. Differences in fertilization or exchangeable potassium in the soil would hardly account for this difference from the other areas. The trend is similar to that noted in cabbage analyses. The calcium uptake for the organic soils of the Sarasota area was low despite the relatively high level of exchangeable calcium in the soil.

The variation in protein content of celery is explainable on the basis of soil organic matter. Celery grown in the mineral soils of the Sanford area averaged only 14.8 percent protein while that grown on the organic soils of the Belle Glade and Sarasota areas having large quantities of organic

nitrogen contained 17 and 17.1 percent protein, respectively.

There was a wide variation between the phosphorus and protein content of tomatoes grown in different areas on different soil types. The phosphorus percentage of tomatoes grown on Immokalee, Charlotte and Pompano fine sands of the Ft. Pierce and Ft. Myers areas was much higher than for tomatoes grown on the Ochopee marl of Collier County and Perrine marl of the Homestead area. Within the Ft. Pierce area, the data show that tomatoes assimilated more phosphorus from the Pompano fine sands than from the Charlotte fine sands. The latter contained less soluble phosphorus and received less fertilizer.

The protein content of tomatoes apparently did not correlate with soil factors. Season may have been the cause of recorded differences inasmuch as the high protein tomatoes grown in Collier County and at Ft. Pierce were harvested in April and May, respectively, while the other 3 areas were harvested between November and February and contained less protein.

The magnesium content of tomatoes showed little variation even though there was considerable variation in exchangeable magnesium in the soil. The calcareous soils contained much more exchangeable potassium than the sandy soils, but only in the case of marl soils was the potassium content of the tomatoes high. The calcium content of tomatoes was greater when grown on the calcareous soils than when grown on acid soils. The iron content was lowest in tomatoes grown on Perrine marl in the Homestead area. The Rockdale limestone soils at Homestead contain a high iron bearing colloid of lateritic origin which supplies adequate available iron.

There was no apparent correlation between soil and plant composition for collards grown in the Quincy area. The protein, calcium and magnesium percentages in collards were higher than in any of the other vegetables analyzed, yet the soils in which the collards were grown were comparatively low in organic matter, calcium and magnesium. The collards grown under tobacco shade on the fertilizer residue left from the tobacco crops, and those grown with fertilizer in open fields were similar in mineral quality.

The primary interrelationships that characterized soil types appeared to be between organic matter content and pH of the soil, with other factors of soil environment and moderate differences in fertilization of secondary importance.

A survey of the literature on plant composition shows that Florida vegetables are as often above as below vegetables from other areas in mineral composition.

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# A FERTILITY EXPERIMENT WITH TOMATOES ON IMMOKALEE SAND IN ST. LUCIE COUNTY

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As has been indicated in the preceding discussion, the survey of tomato crops in St. Lucie County conducted during the 1946 fall cropping season indicated the need for additional amounts of available calcium and magnesium in the soil and the beneficial effects of minor elements. A series of fertility plots was set up for the 1947 spring tomato crop in order to evaluate these factors in the production of tomatoes.

The location chosen for this experiment was an area of Immokalee sand of very low fertility. The surface soil was a light grey sand with a pH of 4.75 and an organic matter content of 0.8 percent. The "B" horizon was a very light grey or light yellow sand underlain by an acid clay, pH 4.95, at a depth of 30 to 36 inches. A fall crop of tomatoes grown on this field showed many symptoms of severe nutritional deficiencies and was almost a total failure.

Four main treatments consisting of three liming materials and a check were laid out in a 4 x 4 Latin square design. The liming materials, basic slag, dolomite and hydrated lime, were broadcast at the respective rates of 2000, 2000, and 1000 pounds per acre. Each of the sixteen main plot, was split into three sub-plots consisting of the following three sub-treatments:

- (1) 4-8-8 fertilizer (check).
- (2) 4-8-8 fertilizer containing 2 percent soluble MgO.
- (3) 4-8-8 fertilizer containing 2 percent soluble MgO plus 0.3, 0.4, 0.2, 0.15 and 0.3 units respective-

ly of CuO, MnO, ZnO, B<sub>2</sub>O<sub>3</sub> and Fe<sub>2</sub>O<sub>3</sub> using the sulfates of copper, manganese, zinc and iron and borax as the source of these materials.

The liming materials were broadcast and disced into the soil in December. In January narrow beds were plowed up seven feet apart and fertilized at the rate of 500 pounds per acre with the mixed fertilizer according to sub-treatments 1, 2 or 3. The first lot of tomato seedlings transplanted to the plots was destroyed by the February freeze. Another lot of seedlings of the Grothen's Globe variety was transplanted to the plots in March. The tomatoes received three side dressings at 500 pounds per acre with this same fertilizer during the subsequent growth of the crop making a total application of 2000 pounds per acre. Approximately three months after application of the liming materials, soil samples were collected from each of the sixteen main plots. The samples were taken from the unturned strips of soil between the beds so as to avoid contamination with the side dressed fertilizer applications. The results of soil analyses for pH, calcium and magnesium made on these samples are recorded in Table 1. The liming materials had raised the pH values and the calcium levels. In addition, the magnesium levels on the dolomite plots were much higher and somewhat higher on the plots receiving basic slag. The soil levels of available calcium and magnesium had their influence on plant composition as determined by tissue analyses made on stem tissue samples collected during the growth of the tomatoes.

Samples of plant stem tissue were collected for analysis from all the sub-plots about the time of the first picking of to-

atoes. Each sample was cut from a position near the end of a growing branch of the plant. The branch was first cut about twelve inches from the end and about six inches of the growing point was discarded along with all the leaves. Twelve stem sections from as many plants were collected from each plot and were composited to make up a representative sample. Cross sections of these stem tissue samples were processed with an extracting solution in a Waring Blendor and the filtered extracts analyzed for calcium magnesium, phosphorus and potassium.

The results of calcium tests on the tomato stem tissue extracts are recorded in Table 2 according to averages for the twelve main treatment x sub-treatment combinations. An analysis of variance showed the calcium content of the stem tissue to vary significantly with the soil amendment used. Samples from the check treatment (main plot treatment) were the lowest with those from the slag and lime treatments highest and dolomite intermediate. This correlates quite well with the calcium in soil samples from these same plots (see Table 1.)

The results of magnesium tests are recorded in Table 2. An analysis of variance showed highly significant differences between

both the four main treatments and the three sub-treatments. Samples from the main treatment check plots were significantly lower in magnesium than those from any of the plots receiving a liming material. The dolomite treatment was significantly higher than the other treatments. This is in good agreement with the soil tests for magnesium (see Table 1). In addition to the magnesium variable due to main treatments there is also a magnesium variable due to sub-treatments. Samples from the check sub-treatment were significantly lower in magnesium than those from the other two sub-treatments which included 2 percent soluble MgO in the fertilizer.

The first picking of fruit was made fifty days after the seedlings had been transplanted to the field. A total of five pickings was made from these plots during the following month. No sorting or grading of the fruit was attempted. A careful check of the accumulated yield totals after the third picking showed that for the first three pickings the plots receiving some form of lime treatment had yielded an average of 130 field crates per acre as compared to 50 field crates for the check plots, a ratio of almost 3 to 1. Since these three pickings were made during the period of high market and subsequent pickings during a much

TABLE 1—ANALYSES<sup>1</sup> OF SOIL SAMPLES COLLECTED FROM PLOTS APPROXIMATELY THREE MONTHS AFTER APPLICATION OF SOIL AMENDMENTS

Treatment	pH <sup>2</sup>	Ca <sup>3</sup> lbs. per A.	Mg <sup>3</sup> lbs. per A.	P <sup>4</sup> lbs. per A.	K <sup>5</sup> lbs. per A.	Organic Matter, <sup>6</sup> Percent
Check	4.75	169	10	8	34	0.83
Basic Slag	6.13	495	35	9	36	0.78
Hydrated Lime	6.56	497	18	9	36	0.82
Dolomite	6.31	413	113	10	35	0.76

<sup>1</sup> Average of four replicated plots.

<sup>2</sup> Glass electrode method.

<sup>3</sup> Extracted with 0.5 N. acetic acid.

<sup>4</sup> Water soluble.

<sup>5</sup> Dichromate—ferrous sulfate method.

lower market, there was a large monetary return from the use of liming materials to produce heavy yields of early maturing fruit. During the fourth and fifth pickings there was a slight leveling off in the comparative yields between treatments. This was because the vines on the check plots died early and the exposed green fruit ripened somewhat prematurely and gave abnormally heavy yields, particularly during the fourth picking. The superior vegetative condition of the treated plots as compared to the check plots became obvious about the time of the first picking. This difference became greater as the picking season progressed.

The average yields in field crates per acre of the five combined pickings are listed in Table 3 according to main and sub-treatment combinations. An analysis of variance of the original data showed the differences between main treatments to be highly significant. The check treatment gave a significantly lower yield than the other three main treatments. Basic slag and hydrated lime gave the highest yields but their increase over dolomite was not significant. There were no differences in yields between the sub-treatments, however, at the end of the third picking the check sub-treatment had yielded approximately 12 percent less fruit than the other two treatments.

There are two characteristics that are sometimes exhibited by tomatoes in the Ft. Pierce area that lower quality. One is lack of firmness due to puffy interiors and the other is an internal browning and hardening of small sections within the fruit with no evidence of damage on the exterior. These necrotic sections have the appearance of granules of brown, cork-like material. During the third picking of tomatoes six fruit samples were collected at random from each of the sub-plots. These samples were brought to the laboratory and cut in half in order to study the above mentioned internal qualities more carefully.

The samples were scored for puffiness on the basis of solid = 0, average = 1

TABLE 2.—CALCIUM AND MAGNESIUM ANALYSES<sup>1</sup> OF STEM TISSUE SAMPLES FROM TOMATO FERTILITY PLOTS

Main Treatment	PERCENT CALCIUM			PERCENT MAGNESIUM		
	Sub-Treatment No. <sup>2</sup>			Sub-Treatment No. <sup>2</sup>		
	(1)	(2)	(3)	(1)	(2)	(3)
Check	0.62	0.49	0.65	0.59	0.33	0.43
Basic Slag	0.77	0.73	0.76	0.75	0.46	0.43
Hydrated Lime	0.76	0.75	0.68	0.73	0.48	0.46
Dolomite	0.64	0.60	0.67	0.64	0.54	0.65
Average <sup>3</sup>	0.70	0.64	0.69	0.68	0.45	0.49
				Average <sup>4</sup>		
					0.33	0.42
					0.44	0.57
					0.44	0.44

<sup>1</sup> Averages of the four replicated plots of each treatment combination. Reported on the basis of oven-dry tissue.

<sup>2</sup> Sub-treatments are (1) check, (2) soluble MgO and (3) soluble MgO plus minor elements with an over-all application of a 4-8-8 fertilizer.

<sup>3</sup> Difference required for significance = 0.11.

<sup>4</sup> Difference required for significance = 0.06.

<sup>5</sup> Differences between calcium values are not significant. Difference between magnesium values required for significance = 0.05.

and puffy = 2. The total scores for the fruit from each treatment are recorded in Table 4. A low score indicates a more solid fruit. According to an analysis of variance, the differences are not significant. However, with the extreme variability and small number of fruits in each sample, such differences would have to be outstanding in order to hold up statistically. The fruit from plots receiving minor elements averaged somewhat less puffy than that from the check sub-treatment. This is in agreement with quality estimates made on fruit from the field of a commercial grower who had fertilized some with minor elements and

treatment than in that from the liming treatments. The differences between the slag, hydrated lime and dolomite treatments were not significant. However, the order of increasing internal browning among these three liming treatments was the same as that of decreasing yields (See Table 3).

Some general conclusions as to recommended fertilizer practices may be drawn from this experiment and the crop survey that preceded it. The fertilizer program on the thinner soils of the Immokalee, Sunniland and Charlotte series, which are mostly used for tomatoes in the Martin-St. Lucie County area, should be such as to produce

TABLE 3.—AVERAGE YIELD<sup>1</sup> OF FRUIT FROM TOMATO FERTILITY PLOTS

Main Treatment	YIELD <sup>1</sup> OF TOMATOES, FIELD CRATES PER ACRE			
	Sub-Treatments			Average <sup>2</sup>
	Check	MgO	MgO Plus Minor Elements	
Check	134	152	167	151
Basic Slag	271	261	288	273
Hydrated Lime	267	262	259	263
Dolomite	245	224	238	235
Average <sup>3</sup>	229	225	238	231

<sup>1</sup>Average yield of ungraded fruit from four replications.

<sup>2</sup>Difference between main treatment averages necessary for significance = 48

<sup>3</sup>Difference between sub-treatment averages are not significant.

some without. In this test the same minor element mixture improved the external appearance of the fruit as well as firmness.

The fruit samples were also scored for the internal browning condition according to the basis of none = 0, slight = 1, medium = 2 and severe = 3. The total scores for each treatment are recorded in Table 4. As in the case of puffiness, a high score indicates a large amount of the necrotic condition with its resultant poor quality. An analysis of variance of these data showed significant differences between main treatment averages. There was more necrotic tissue in the fruit from the check

a soil pH of approximately 6.00 - 6.50, an available calcium content of 500 pounds per acre and a magnesium content of 50 pounds per acre. If the soil pH is below 5.00, one ton of dolomite, calcic limestone or basic slag, or one-half ton of hydrated lime may be safely used. The use of soluble magnesium in mixed fertilizer should be determined by the magnesium content of the soil and the liming material to be used. The use of minor elements in the mixed fertilizer seems to be advisable on these soils. The maximum amounts recommended on the first crop are 0.3, 0.4, 0.2, 0.15, and 0.3 units of CuO, MnO, ZnO, B<sub>2</sub>O<sub>3</sub> and Fe<sub>2</sub>O<sub>3</sub>,



# WATERMELON DISEASE CONTROL

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In Florida there are a number of diseases that attack the watermelon (*Citrullus vulgaris*), but fortunately their severity is seldom very great. However, certain of the diseases may destroy the crop under conditions favorable for their development, and it is seldom that a field is observed in which one or more of the several diseases of watermelons are not doing some damage. Interestingly enough, we have no serious bacterial or virus diseases of melons of Florida, for the angular leaf spot of cucumber, *Pseudomonas lachrymans* (E. F. Sm. and Bryan) Ferraris, Bacterial wilt, *Erwinia tracheiphila* (E.F.Sm.) Holland, and cucumber mosaic do not attack melons with any certainty. For the most part the watermelon grower has to fight fungus diseases and rarely the nematode *Heterodera marioni* which causes root-knot. My talk today therefore, will be confined to the fungus diseases that confront a watermelon grower in Florida and their control.

The first disease we shall consider is *Fusarium wilt*, caused by *Fusarium oxysporum f. niveum* (E.F.S) Snyder and Hansen, sometimes erroneously called "blight" by the melon grower. This fungus disease attacks susceptible varieties through the roots, which then cease to function, the water conducting system gets plugged and the melon vines wilt, at first temporarily, later permanently, and then die. Plants may be attacked early in their life, or may grow in an apparently normal manner, even bear fair sized melons, and then suddenly wilt and die. Losses may be as low as 80 percent or as high as 100 percent. Growers

have learned, through hard experience that wilt lives in the soil from year to year, and that a period of at least 5 years, better 8 to 10 years, should elapse between crops of melons on the same ground. I am speaking of varieties that are susceptible to wilt, such as the now predominant Cannon Ball, also called Florida Giant, Clara Lee, or Black Diamond, the formerly predominant Tom Watson, the Dude Creek, Dixie Queen, Garrison, and so on. In order to develop a variety that would withstand wilt, that could be planted on so called "old" melon land without a long wait between crops, the present watermelon laboratory at Leesburg was started in 1930, with Doctor Marion M. Walker in charge of the research. Doctor Walker worked at Leesburg from 1930 to 1942, and was able to develop a number of varieties that are highly resistant to wilt, namely the Leesburg, the Blacklee, and two unreleased varieties that we call the Improved Leesburg and the Brownlee. The Leesburg was a selection out of the variety Kleckley Sweet, which showed some resistance when studied first in 1932, and it looks like the Kleckley Sweet. Released to melon growers for trial in 1935-36, the variety while highly resistant to wilt and of superb quality was not liked by growers who considered it to be too small, it sunburned, and its white seeds were rather frowned upon. It would, however, make a crop if planted on old melon land. Undaunted, Dr. Walker crossed the white seeded, dark rind Leesburg with the black seeded, rather light colored Hawkesbury which had been developed by the Australians. Out of the Leesburg x Hawkesbury cross has come the wilt resistant Blacklee, the Brownlee, and the Improved Leesburg all appreciably larger than the Leesburg, and like the Leesburg of superb quality. The Blacklee was released



in 1943-44; since then it has been planted less and less each year in Florida because it is somewhat small by comparison with Cannon Ball, but more damaging it is 7 to 10 days, sometimes 14 days, later to mature than the wilt susceptible Cannon Ball. The melon grower in Florida is a gambler, he is betting his money against Florida frost, rain, drought, disease, and last but not least the weather in Georgia. If he gets an early crop he sells his cars of melons, roughly 900 to a car, for \$800.00 to \$1800.00 a car; if the crop is delayed for any reason, the price can drop 25 to 50 percent. Why should he add a certainty to late maturity, a late maturing variety? So, despite top quality and wilt resistance, the Florida melon grower shies away from Blacklee and continues to plant Cannon Ball. Where does he get new land, or 8-10 year old land? He is pushing farther and farther back into the woods; his trucking bill is getting rather large and soon he may be forced to use old land on which the Cannon Ball cannot grow. In other words he may be forced to plant Blacklee. We may be able to get him a wilt-resistant Cannon Ball before that happens; we are rushing that phase of our research at Leesburg.

As a sidelight on the Blacklee, this variety has been accepted and is liked in states such as Virginia, Missouri, Delaware, Maryland, Texas, Oklahoma and New Mexico which are places less interested in earliness. This summer I saw many melons in Michigan and Indiana that were without doubt our Blacklee. So, the work of Doctor Walker has not been entirely in vain. Brownlee and Improved Leesburg do not seem to be much earlier than the Blacklee and I doubt if Florida growers will like them or use them until they have to. We are attempting to improve the Blacklee by making selections for earliness. In summation, for control of Fusarium wilt, use wilt-resistant varieties or land that has not supported melons for 8 to 10 years if susceptible varieties are used. Our work at Leesburg has shown that if wilt resistant

varieties are planted on old melon land, do not do so until 2-3 years have elapsed since melons were last planted.

Watermelon anthracnose and watermelon gummy-stem blight are 2 important stem, leaf, and fruit diseases that can be discussed together, for initial steps in their control are based upon seed treatment. The spores of the fungi that cause these diseases, *Colletotrichum lagenarium* (anthracnose) and *Mycosphaerella citrullina* (C.O. Sm.) (Cross, (gummy-stem)), are carried on watermelon seeds and establish the 2 diseases in or around the melon hills, from there spreading rapidly throughout the field.

I have seen gummy-stem blight cause losses in melon stands of 30-90 percent, simply because the grower was ignorant of the necessity of seed treatment or just too stubborn to follow instructions. A grower told me in 1946 that gummy-stem blight cost him \$9000.00, yet the following year he forgot to treat his seed! While anthracnose usually does not cause seedling losses in melon plantings in Florida, if carried into the field on seeds the disease can be found early in the growth of the melon vine and builds up as it defoliates the plant and finally the young fruits are infected. It is the worst disease of melons in our state. Under favorable weather conditions, particularly rainy spells, anthracnose is to be feared and inspectors quickly reject mature melons that show the characteristic bumps on the skin that we know are latent anthracnose infections. Such infected melons carry poorly, and they rot or decay before final disposition by the consumer. The simple, easy, and cheap seed treatment with Spergon or Semesan, at 3 tenths of 1 percent, or 1/3 pound per 100 pounds of seed, takes care of anthracnose and gummy-stem blight spores and the melon vines get a good start. Some seed houses in Florida are now selling melon seed already treated; this is a good practice and should be more widely adopted. The seedsman often has more time and facilities to treat seed than the farmer, who will faithfully treat seed

for the first 2 plantings but be in too much of a hurry to take the time to treat subsequent plantings if they are needed.

Even if treated seed is planted there is no guarantee that anthracnose and gummy-stem blight will not come into the melon plantings. They come from fields of growers who did not treat their seed, or they can be blown by the wind from last year's melon soil in which the fungi live as saprophytes. To control the diseases once they appear in the field can be done fairly satisfactorily by spraying or dusting with any one of a number of fungicides. To name a few, good control of anthracnose has been obtained in Leesburg with Ferlate, Dithane, copper-lime, or tribasic copper sulfate, applied as dusts. Fairly satisfactory control has been obtained with Copper A and Zerlate. Spergon has not been tried. We have not worked with sprays because we feel that dusting is more adapted to watermelon culture than spraying, but this is a point we do not have the time to discuss here now. The question has come up very forcibly, "Does it pay to apply fungicide?", and in my 1947 trials while I obtained very nice control of the leaf diseases anthracnose and downy mildew, the latter of which I will refer to later in more detail, when data were converted to dollars and cents there seemed to be no great value obtained by dusting. In fact, with earliness a distinct advantage to the melon grower, it was noted that melons matured more slowly on dusted vines than on the undusted checks. The reason for this is that the fungi were knocking down the leaves on the checks and the melons were maturing faster. Even though the dusted vines produced more melons in aggregate than the check vines, the grower made as much money off the checks as he did off the dusted vines. This may be due to chance, 1947 was peculiar in other respects, but it does illustrate what I wish to bring out, how is one to decide if one should recommend the application of a fungicide? Research, year after year, alone will answer

the question. We will, at the same time, find out which is the best fungicide to use.

Also of value in control is keeping out of melon fields when the vines are wet, which spreads the fungi. Research is under way at Leesburg to develop an anthracnose resistant variety of melon. If successful, spraying or dusting will not be necessary for control of this disease. In summation, for gummy-stem blight and anthracnose control, the melon seeds should be treated, with either Spergon or Semesan, before planting. If sprouted seeds are planted, the 1-1000 corrosive sublimate treatment, followed by the thorough washing in running water or several changes of water may be substituted. If it is desirable to dust or spray, present findings advise the use of Dithane-zinc-lime or tribasic copper sulfate for the best control of anthracnose, but we do not yet know when or how often to apply the fungicides under average conditions. Labor should be advised to stay out of the melon fields when the vines are wet with dew or rain.

The next disease we must consider is downy mildew, caused by the fungus *Peronosporopara cubensis* (B. and C.) Rost., which annually is the worst disease of cucumbers in Florida, and since cucumbers are widely grown during most of the year, there is an abundant source of inoculum for watermelons. The fungus overwinters in the Everglades or farther south on wild cucumbers or volunteer cucumbers or even on cucumbers in small backyard lots and kitchen gardens out of the range of frost. No one has shown that downy mildew in Florida in the spring is not initiated from Cuba. Some years anthracnose precedes downy mildew, other years the reverse is found. In the leaf spot stage it is not always easy to separate the two diseases by outward appearance and for final analysis a microscope may be needed. Downy mildew does not attack the stem or fruit of the melon. Inasmuch as the mildew spores are not carried on the seed, but blown in by the wind, seed treatment is of

no value against mildew. What has been said of dusting or spraying for anthracnose control applies equally well for fungicide application against downy mildew. At Leesburg in 1947 we obtained excellent mildew control but in the final analysis which totals the receipts from dusted versus non-dusted plots, we are not so sure that it paid to apply a fungicide. We know that Fermate, Zerlate, Dithane, Copper A, tri-basic copper sulfate, or copper-lime dust give good control. We have not tried Spergon which gives good control of downy mildew of cabbage and which might do the same for downy mildew of cucurbits though the same species of fungus is not implicated. In summation for downy mildew control, dusting or spraying can be performed, but more research is needed to show when to apply the fungicide and how often.

It is worthy considering a disease forecasting service for watermelon growers, similar to such services now available to apple growers, cucumber growers, tomato and potato growers, in other parts of the nation. Such a service would tell growers what diseases threatened the melon crop, and whether application of a fungicide was advised. In Lake county alone around 10,000 acres of melons are planted every year. The cost to dust, or spray, one acre of melons is roughly \$1.30 to \$1.50. If only half this acreage is dusted once, the cost is \$6,500.00 at least, possibly \$7,500.00. If dusted twice around \$14,000.00. Most growers dust or spray at least once for dis-

ease control and most dust or spray twice or three times for aphid control and the fungicide could easily be applied with the insecticide. Dusting or spraying for the insects is performed knowing that the insect is there; the same cannot be said of application of the fungicide. If the cost of one fungicide application could be saved the melon growers through accurate knowledge of the fungi, their abundance or inoculum potential and associated factors in their development, the saving would more than pay the salary of the trained personnel needed for the 5-month job of constantly patrolling the melon fields; February thru June should suffice. The idea has been sown before but it has not taken root or borne fruit to the present. There is no good reason why it should not work.

Other diseases present in Florida which are less important are Southern wilt (*Sclerotium rolfsii*), stem-end rot (*Diplodia sp.*) which is easily controlled by treatment of the stem ends of melons before shipment, blossom-end rot (*Pythium debaryanum*), powdery mildew (*Erysiphe cichoracearum*), ground rot (*Corticium vagum*), and several leaf spots associated with species of *Cercospora* and *Macrosporium*. The virus mosaic has been found in Florida but it is irregular in appearance and not considered serious. All of these are well discussed in bulletin 225 of the Florida Agricultural Experiment Station entitled "Diseases of Watermelons in Florida."

# AN EVALUATION OF TOMATO PRODUCTION PROBLEMS IN THE ST. LUCIE-MARTIN COUNTY AREA

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## *Introduction—*

The Ft. Pierce vegetable section which includes parts of Indian River, St. Lucie and Martin counties has undergone a rapid expansion in tomato production in recent years. The center of the area lies west of Ft. Pierce with substantial acreages planted in St. Lucie County. The balance of the tomato acreage is rather scattered as one proceeds northward into Indian River County and southward into Martin County.

While some tomatoes are produced on lands which are definitely marginal, there is a considerable acreage grown on land which is well adapted to the production of satisfactory yields of good quality tomatoes. Much of this more productive soil lies fallow or in cattle-pastures, since growers have experienced excessive crop losses on land which has been previously cropped to tomatoes. Most producers prefer to move to virgin soil each season in order to escape certain problems which seem to be intensified on old tomato land. Much of the better soil accessible to roads has thus been used and growers find it necessary to establish farms at increasing distances from paved roads and markets in order to plant on virgin soils. The expense of road building, dyking, ditching, clearing, bridge building and pump and well installations must be charged off to a single tomato crop. The practice of moving to new soil each season is thus an expensive one, and it is quite obvious that this new land of good quality

is becoming increasingly difficult to obtain. Consequently, the future outlook appears to be a forced return to much of the old tomato land, or a sharp reduction in the tomato acreage.

Vegetable crop studies were initiated in the Ft. Pierce area in August, 1946 with the following objectives: to determine the factors responsible for excessive crop losses on soils previously cropped to tomatoes; to find improved tomato varieties with the necessary disease resistant characteristics; to determine the best fertility and soil management practices and to investigate methods of disease and insect control.

## *Fall Survey—Methods and Discussion.—*

A rather extensive survey study of commercial tomato plantings on virgin soils and on soils previously planted to tomatoes was made during the fall tomato season of 1946. Special attention was given to soil analyses; fertilizer formulations and placement; disease and insect diagnoses and incidence; cultural practices, including weed and grass problems; and water control. The primary purpose of this preliminary survey was to study and evaluate the problems confronting the tomato producers. The study was successful in revealing some of the causes for crop losses on second year tomato land and in determining some of the limiting factors on virgin soil. Only the more important problems are discussed in this paper.

A group of commercial tomato plantings was selected for observation and study throughout the season. These farms were selected in such a way as to represent several of the more important soil types upon which tomatoes are grown in this area. The

cropping history was obtained on these farms, and special attention was given to the method of cultivation, fertilization, planting and spraying or dusting. Soil samples were collected and analyzed for pH, calcium, magnesium, and organic matter. Where a variation of soil type existed, or where evidence of poor growth was noted within a field, soil samples were obtained to represent the most vigorous growth as compared with those areas of poor growth or definite foliage deficiency symptoms. Disease and insect incidence was noted and plant material was sent to several State plant pathologists for disease identification. Miscellaneous observations as to grass and weed problems, erosion and water control were made. Various growers and suppliers were questioned in order to obtain their reaction to returning to farms which had previously cropped tomatoes.

The fall season, 1946, proved to be an opportune one for a study of this nature and some interesting and important information was obtained, serving as a foundation for future research studies. Several of the more important production problems are discussed.

#### *Soil Management.—*

Some commercial plantings of tomatoes were located on Leon, Immokalee and Sunniland soils where the natural cover had been pine and scrub palmetto with a sparse growth of grass. The pH values of these soils fall within an approximate range of 4.40 to 5.00 with calcium contents of 40 to 200 pounds per acre, and magnesium contents of 3 to 20 pounds per acre. Magnesium and other unidentified deficiency symptoms were prevalent in these plantings. Except for spot treatments of hydrated lime on areas from which dense growths of palmettos were cleared, very few growers applied any liming material on these acid soils. The plant growth and yield were generally poorer on these soils than on the soils with a more favorable pH range.

A majority of the commercial plantings were located on soils of the Charlotte, Sunniland, Arzell and Pompano series with pH values of 5.20 to 6.70, magnesium levels of 15 to 40 pounds and calcium levels of 150 to 400 pounds per acre. The natural cover in this case had been mostly grass prairie interspersed with cabbage palm hammocks and some palmetto. Tomatoes on these soils were generally good, though there was some indication of response to applications of soluble magnesium and secondary elements.

Certain smaller areas in the tomato growing section included in the survey contained a considerable amount of alkaline clay near the surface mixed with the top soil. Here the pH values ranged from 5.80 to 7.00 with magnesium levels of 30 to 90 pounds and calcium levels of 500 to 1100 pounds per acre.

Serious loss of basic elements by leaching under cultivation is an important problem in the area. Leaching on these soils is demonstrated by the fact that samples taken from a field in early August before drainage was initiated showed an average pH value of 6.07. Two months later after drainage, planting and cultivation, and a period of heavy rainfall, the pH of the surface soil had dropped to an average of 5.49. There is evidence that excessive leaching may be a factor contributing to the poor crops generally obtained on soils previously cropped to tomatoes.

Erosion of plant beds during heavy rainfall presents an important problem which is intensified in areas under continuous cropping. The grass flats on virgin soil are usually mowed and raked, but are not plowed or disced before the beds are thrown up. The grass sod is thus utilized in the plant bed to prevent excessive erosion. Two shallow sod furrows are thrown together to form the base of the bed and a deeper sand furrow is thrown upon this sod. Seed are immediately drilled with a mechanical seeder in order to take advantage of the moisture in the fresh bed for seed germina-

tion. The initial fertilizer application consisting of 300 to 700 pounds per acre of a 4-7-5, 4-8-6 or 4-8-8 commercial fertilizer is placed (1) below the seed before the sand furrow is thrown up; (2) above the drill immediately following seeding, or ((3) part applied below the drill and part above the drill. The additional three to four side dressed applications of a 4-8-6 or 4-8-8 fertilizer are applied at the rates of 400 to 600 pounds per acre as the plant beds are built up by means of plowing furrows to each side. The last application of fertilizer is applied at or shortly after blooming begins when the tomatoes are "laid by." Some growers apply approximately 200 pounds per acre of nitrate of potash shortly after picking begins, especially if excessive rainfall has occurred.

On previously cropped soils the general practices are similar, except that it is necessary to plow or disc the soil before preparing the beds in order to control weeds and grasses. These plowed soils are especially susceptible to serious erosion when bedded since the coarse sand of low organic matter content has nothing to bind it. Weeds and grasses present a much more serious problem on these old farms, necessitating hand hoeing in many cases. During a period of frequent rainfall which is typical in the case of the fall crop, weed control is extremely difficult.

#### *Disease and Insect Problems.—*

The survey revealed a number of diseases attacking tomatoes which were responsible for substantial losses in many cases. The general disease problem was definitely more severe on second year tomato land, but several diseases appeared on tomato crops planted in virgin soil. Important insect problems appeared during the course of these investigations. DDT was used quite generally throughout the area and gave very good control of several of the common insect pests. No reports of reduced yields which could be attributed to this commercial use of DDT were forthcoming. Several

growers reported that DDT had given the highest percentage of worm free fruit they had ever produced. The more important diseases and insects appearing during this study are discussed briefly.

Fusarium wilt, *Fusarium bulbigenum* var. *lycopersci* (Brush) Wr. and Reinking was one of the most serious diseases appearing on the fall crop in the St. Lucie-Martin County area. This disease was extremely severe on second year tomato land, causing heavy losses in most cases. It is estimated that fusarium wilt alone caused an average of thirty percent loss on this second crop soil. Several plantings were visited where fusarium wilt had attacked 100 percent of the crop. While tomatoes planted on virgin land were not affected seriously by fusarium wilt, nearly all of these plantings contained a light to moderate infection with some crop loss. Much of this virgin land was sufficiently infected with wilt to offer a serious threat to a second crop of tomatoes. It can be definitely stated that fusarium wilt is one of the chief limiting factors in successful production of tomatoes on second year tomato land. Since this is a soil borne disease which attacks through the root system and survives for long periods in the soil, the logical attack of this problem appears to be tomato breeding for a satisfactory tomato which is resistant or immune to fusarium wilt.

Stemphylium leafspot, *Stemphylium solani* Weber, may be placed as second in importance during the fall of 1946. While it has been difficult to separate this disease from soil deficiency symptoms and other foliage diseases, it appears that stemphylium leafspot was one of the chief diseases on tomatoes. None of the commercial fungicidal treatments seemed to be effective in controlling this disease, and every planting visited was affected almost 100 percent at some stage of growth. The disease became severe when the vines were maturing a maximum of fruit and caused a rapid decline of the foliage thus affecting the yield and quality of the fruit. In the variety

trials the only tomato which was not affected with this disease was Wst 1-20, a USDA line carrying resistance to fusarium wilt and to stemphylium leafspot.

Late blight, *Phytophthora infestans* (Mont.) DBy. was first discovered in the variety trials in October and was later found near Stuart and in several of the commercial plantings in the Ft. Pierce area. Late blight was widespread and serious throughout the winter and spring. Only those producers who were able to maintain a careful spray or dust schedule were successful in controlling this disease.

Other diseases appearing during the survey, and causing moderate losses in some plantings were Bacterial spot, *Phytophthora vesicatoria* (Doidge) Bergey et. al; Bacterial wilt, *Phytophthora solanacearum* Erw. Smith; Blossom end rot; Early blight, *Alternaria solani* Ell. and Mart.; Leafmold, *Cladosporium fulvum* (Ke.) Soil rot, *Rhizoctonia solani* Kuhn; and a virus disease similar to the sugar beet curly top virus which attacks tomatoes in the far west.

Mole crickets, *Scapteriscus acletus* R. and H. and *S. vicinus* Scud. occur generally throughout the area. On virgin land they are not usually abundant enough to cause serious damage to crops, but after one year's cropping mole crickets often increase in population to such an extent as to threaten any succeeding crop of tomatoes if the seed is drilled in the field. Summer flooding with ditch bank baiting and transplanting to the field from seed beds should reduce damage by mole crickets.

Serpentine leaf miner, *Agromyza pusilla*

Meigen built up on the fall tomato crop and a mass emergence of adults at the time the spring crops germinated resulted in very severe damage by the leaf miners to the young tomato seedlings. Prolonged warm weather may have been responsible for the heavy build-up of this insect in the fall and winter.

Other insects appearing in the area included aphids; thrips; tomato horn worms, *Protoparce* sp., southern armyworm, *Xylomyges eridania* Cramer; tomato fruit worm, *Heliothis obsoleta* Fab.

#### CROP ROTATION AND DIVERSIFICATION

For the past few years the Ft. Pierce vegetable crop area has been devoted almost entirely to tomatoes. In order to stabilize this area as a truck crop section it would appear that there is a definite need for diversification. In order to formulate a crop rotation plan for weed and grass control, and to reduce damage by insects and diseases, it will be necessary to include vegetable or field crops which do not harbor the same diseases and insects as do tomatoes. From the preliminary work conducted in this section it appears that a number of vegetable crops are well adapted and may be used in rotation with tomatoes. A good summer crop which will withstand considerable water is needed for the area. Sesbania is used for this purpose in certain cases and does quite well when high water levels are maintained. Otherwise there is some question as to the advisability of using sesbania due to the possible increase in nematodes following this crop.

# IRRIGATION STUDIES WITH SWEET CORN, CABBAGE AND SNAP BEANS AT GAINESVILLE

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The practice of irrigation originated about the same time as man and at the same place, in the Garden of Eden, according to Genesis 2:10. Since that time man has realized the value of irrigation and has built his communities, cities and even nations in areas where water could be secured for the irrigating of his crops. Despite the fact that the State of Florida has an annual precipitation of 52 inches of rainfall its distribution is such that growers are aware of the need for irrigation. This is evidenced by the large acreage of vegetables being produced on land where provisions have been made for the addition of water by many methods of application.

An experiment was started at Gainesville in 1945 to determine the effectiveness of irrigation in improving the yield and quality of vegetables. The experimental plots were located on Arredonda loamy sand with the soil having some variations in moisture equivalents. Individual plots were approximately 1/24 acre in size with sufficient aisle space to prevent the overlapping of the several irrigation treatments. A temporary sprinkler irrigation system was used the initial year of the experiment but was replaced after that year by a permanent overhead sprinkler irrigation system. The latter system consisted of an oscillating nozzle on a single upright for each individual plot.

Sweet corn was grown as a spring crop the initial year on replicated plots irrigated with the temporary system and cabbage and snap beans have been grown as winter and spring crops respectively on the replicated

plots irrigated with the permanent system for the past two years. Moisture treatments given the vegetables were: (1) no irrigation; (2) light irrigation to maintain the soil moisture above the point where permanent wilting would occur; (3) heavy irrigation or twice the amount applied in the light irrigation treatment to maintain the moisture nearer the moisture holding capacity; (4) the same amount of water as applied in the heavy irrigation treatment but divided into two applications three days apart. Due to operating difficulties the split treatment was not applied to plots planted to sweet corn during the first year of the experiment.

The timing of irrigation applications was made on a weekly schedule with sweet corn. The time for irrigating cabbage and beans during 1946 was determined from visual observations of the vegetables and soil for signs indicating the need for water. Soil moisture determinations were also made to check these observations. However, the following year an evaporimeter was employed to assist in determining the time for application of irrigation water. An attempt was made to irrigate the vegetables after 1 inch of water had evaporated from an open tank which was 48 inches in diameter and 10 inches deep. Soil moisture determinations were made as a further check prior to each irrigation.

The amount of water applied at each individual irrigation has varied from year to year. All sweet corn plots received water at the time of planting to assure germination and after that irrigation one set of plots received no additional water until after the first harvest was made. The plots receiving the light irrigation treatment received 1/2 to 3/4 inch of water each week, while the heavy irrigated plots received twice this



amount. The amount of water applied to cabbage and beans in the winter and spring of 1946 varied from 1/4 to 1/2 inch per individual application to plots receiving the light amount of irrigation. Twice this amount was applied as individual application to plots receiving the heavy amount of irrigation. The amount of each individual application was increased for cabbage in the winter and beans in the spring of 1947. The four moisture treatments were made by applying the following approximate amount of water respectively for each treatment at the time of irrigation: (1) no water; (2)

1/2 inch of water; (3) 1 inch of water; (4) 1 inch of water divided into two applications of 1/2 inch of water separated by approximately three days.

Experimental plots planted to sweet corn were divided to test the effect of irrigation on two varieties of sweet corn, Golden Cross Bantam and Illinois Golden 10. The plots were further divided to permit the study of a spacing test using the variety Illinois Golden 10, which was planted at spacings of 24 and 30 inches between hills in the seed row.

During the two winter seasons the experi-

TABLE 1.—COMPARATIVE PRECIPITATION RECORDS FOR THE PERIOD OF THE IRRIGATION STUDIES

Month	Inches of Rainfall	
	Measured Precipitation	Normal Precipitation
<i>Sweet Corn 1945</i>		
March	Trace (1)	3.35
April	4.28 (1)	2.40
May	2.72 (1)	3.15
<i>Cabbage 1945-46</i>		
November	2.00 (1)	1.82
December	9.22 (1)	3.21
January	2.21	3.16
February	2.53	2.92
<i>Beans 1946</i>		
March	2.55	3.35
April	1.88	2.40
May	7.22	3.15
<i>Cabbage 1946-47</i>		
November	.01 (2)	1.82
December	.23	3.21
January	1.55	3.16
February	4.34 (3)	2.92
<i>Beans 1947</i>		
March	4.76 (4)	3.35
April	1.93	2.40
May	.09 (5)	3.15

(1) Weather Bureau Records, Gainesville, Station.

(2) Measured only from Nov. 21 to Nov. 30.

(3) Measured only from Feb. 1 to Feb. 15.

(4) Measured only from March 12 to March 31.

(5) Measured only from May 1 to May 12.

mental plots were planted to cabbage, the individual plots were divided into three equal sections to permit the study of a sub-treatment dealing with the application of nitrogenous fertilizer. These fertilizer sub-treatments were: (A) 1,600 pounds of an 8-7-5 fertilizer per acre; (B) 1,600 pounds of a 4-7-5 fertilizer per acre plus additional nitrogen in the form of two side dressings each of 200 pounds of nitrate of soda; (C) 1,600 pounds of a 4-7-5 fertilizer. All fertilizer, except the side dressings, were applied at planting time. Copenhagen Market, variety of cabbage, was planted in 1946 and Glory of Enkhuizen in 1947.

Two varieties of snap beans were planted each year that beans were grown. Florida

## RESULTS

Normal precipitation (1) is compared in Table 1 with the measured precipitation for the several seasons in which the tested vegetables were grown. Precipitation in the spring of 1945 was lower than normal while in the winter and spring of 1946 it was close to normal. The precipitation recorded in the winter and spring of 1947 was again lower than normal. Because of the distribution and amount of natural rainfall the number of irrigations varied with the individual crop and season. The amount of irrigation water applied to cabbage and beans is given in Table 2.

*Sweet Corn.*—Yields were greatly affected

TABLE 2.—NUMBER OF INCHES OF IRRIGATION WATER APPLIED TO CABBAGE AND SNAP BEANS

Year	Crop	Irrigation Treatment		
		Light	Heavy	Soil Application
1945-46	Cabbage	1.12*	2.44*	2.11*
1946	Beans	1.40	2.84	1.80
1946-47	Cabbage	3.04	5.41	4.89
1947	Beans	3.50	7.04	6.52

\*Initial irrigation at planting not included.

Belle and Logan in 1946 and Stringless Black Valentine and Logan in 1947. In 1946, each of the two varieties used were planted at two spacings. One spacing was at the regular rate recommended with the bean planter employed which was approximately 8 seed per foot of seed row. The second spacing tested was at a lighter rate of approximately 6 seed per foot of seed row, causing a wider spacing between plants. All bean plots received the same fertilizer treatment for the two years which consisted of 1,200 pounds of a 4-7-5 fertilizer per acre. An additional side dressing of nitrogen and potassium was given the beans in 1947.

by irrigation as shown in Table 3. The average yields from the first harvest show that the plots receiving the heavier amounts of irrigation produced approximately 10 times the corn as produced from the plots receiving no irrigation. Yield of corn from plots receiving the light irrigation were a little more than half that harvested from the heavy irrigated plots. Illinois Golden 10 produced the highest yield of corn and with that variety the 30 inch spacing produced more corn at the first harvest than that spaced at 24 inches. It is interesting to note the increase in the yields of the sweet corn after irrigation was applied to all treatments after the first harvest. The yield from the

previously non-irrigated plots increased greatly but the plots irrigated throughout the entire season produced the larger yields.

*Cabbage.*—The data in Table 4 shows the effects of irrigation and fertilizer treatment on the yield of cabbage. During the 1946 growing season in which the precipitation was close to normal there was little differences in the yield of cabbage as a result of irrigation treatment. Small increases in the average yield occurred on plots receiving the light and split application treatment of irrigation. The result of the 1947 season, which had less rainfall than normal, were more pronounced. Increases in yield were secured despite the fact that freezing weather near the end of the season prevented the normal heading of the cabbage and necessitating the harvesting of the cabbage at an immature stage. The highest average yield of cabbage for that season was harvested from plots irrigated by the split application treatment followed by the heavy and light irrigation treatments. The initial stand of cabbage was also affected in 1947 as a result of treatment and a larger number of cabbage replants were required on plots receiving no irrigation. A marked reduction in aphid infestation was observed on plots subjected to irrigation treatments.

Results from the fertilizer study reveal that the highest yield was secured in 1946 by side dressing the cabbage with additional nitrogen. In 1947, no large differences in yield were secured as a result of the fertilizer treatments.

*Beans.*—Irrigation was a factor contributing to the increase of bean yields for both years studied. The results of this study are given in Table 5 and show that the highest yield of beans secured in 1946 was harvested from plots irrigated with the split application treatment of irrigation. This yield was followed closely by that harvested from the plots irrigated with light irrigation treatment. During 1947, which was a much drier year, irrigation was again found to be effective in increasing the yield of beans. The highest average yield of 291.2 bushels per acre of snap beans was harvested from the plots receiving the split application treatment of irrigation, whereas those plots receiving no irrigation produced an average yield of 24.0 bushels of beans per acre. At an average price of two dollars per bushel for beans this would have meant a difference of \$533 in the value of the crop grown under irrigation and that under natural rainfall.

From the data in Table 5 it can be ob-

TABLE 3.—EFFECT OF SEVERAL AMOUNTS OF IRRIGATION ON THE YIELD OF SWEET CORN-1945

Variety	Spacing	Irrigation Treatment		
		Pounds Per Acre		
		No Irrigation	Light Irrigation	Heavy Irrigation
Golden Cross Bantam	24 in.	133.9	704.2	1283.0
Illinois Golden No. 10	24 in.	169.9	823.7	1370.9
Illinois Golden No. 10	30 in.	167.0	1137.6	2041.9
Total Average at First Harvest		156.9	888.5	1565.3
Total Average for Entire Crop		1332.5*	1967.0	2515.2

\*Irrigation made to corn after first harvest.

served that all varieties of beans studied generally exhibited similar reactions to irrigation treatments. No differences between the varieties Logan and Florida Belle, were secured in 1946. Logan, however, did produce more beans than Stringless Black Valentine in 1947.

The spacing of the bean seed at the rate of 8 seed per foot produced a large yield of beans than those bean seed planted and spaced at a rate of 6 seed per foot of seed row during the 1946 season.

#### SUMMARY

The yield of sweet corn, cabbage and snap beans was maintained at a high level by the use of irrigation. Large increases in yield may be expected in dry seasons from the use of irrigation and some increases may also be expected in seasons of near normal rainfall.

An even supply of moisture in the soil

is essential for the best results with cabbage and beans as evidenced by the yields secured from these vegetables for the two seasons when irrigated with the split application treatment of irrigation. In periods of normal rainfall light irrigation appeared to be effective in maintaining the yield of cabbage and beans.

Results indicate that the spacing of the variety, Illinois Golden 10, at 30 inches gave increased yield over the 24 inch spacing in the dry season of 1945. Illinois Golden 10 in this season produced more corn than Golden Cross Bantam.

Side dressing of cabbage with additional nitrogen in the form of nitrate of soda appeared to be effective in increasing yields during the season with near normal precipitation.

#### LITERATURE CITED

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TABLE 4—THE EFFECT OF SEVERAL IRRIGATION AND FERTILIZER TREATMENTS ON THE AVERAGE YIELD OF CABBAGE

Fertilizer Sub-Treatments	Tons Per Acre				Average for Fertil- izer Treatment to 1945-1946** 1946-1947
	Irrigation Treatment				
	None	Light	Heavy	Split	
8-7-5	5.03	5.87	5.13	5.19	5.31
4-7-5 plus side dressing	7.30	9.27	8.00	7.30	7.97
4-7-5	5.24	5.38	4.28	5.49	5.10
Average for Irri- gation Treatments	5.86	6.84	5.80	5.99	
1946-47 Season					
8-7-5	2.28	5.07	5.40	6.76	4.88
4-7-5 plus side dressing	2.28	5.31	6.06	6.46	5.03
4-7-5	2.49	5.34	5.86	7.08	5.19
Average for Irri- gation Treatment**	2.35	5.24	5.77	6.77	

\*\*F value highly significant.

TABLE 5.—THE EFFECT OF SEVERAL IRRIGATION TREATMENTS ON THE AVERAGE YIELD OF SEVERAL VARIETIES OF SNAP BEANS

	Yields of beans in bushels per acre				Average for Va- rieties 1946 and 1947*
	Irrigation Treatment				
	None	Light	Heavy	Split	
Florida Belle	153.3	168.5	153.6	174.0	162.4
Logan	138.9	180.2	154.3	178.4	162.9
Average for Irriga- tion Treatment*	146.1	174.3	153.9	176.2	
1947 Season					
Stringless Black					
Valentine	22.5	180.6	231.0	274.1	177.1
Logan	25.4	213.6	229.7	308.3	194.3
Average for Irriga- tion Treatment**	24.0	197.1	230.4	291.2	

\*F value significant

\*\*F value highly significant

# SWEET CORN IN THE SANFORD AREA

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(Presented in 1946)

With the development of the new hybrid sweet corns and other varieties suitable for this State and with better methods for the control of the corn ear worm the acreage planted to this crop has increased at a rapid rate in the Sanford area. Last season approximately 250 acres were planted to sweet corn in this section. This year the best estimates that we have been able to get place the acreage at 1200 acres with some going as high as 2000 acres. While this shows a tremendous increase, one must take into consideration that the acreage planted to roasting ears has taken a drop almost as great as the increase in sweet corn acreage, thus the total acreage planted to green corn has not increased as much as the figures would seem to indicate.

Corn has long been a favorite crop for planting after celery, but up until a few years ago most of this corn was field corn. With the increased use of tractors and decrease in mule power there has been less demand for this type of corn. Planted after celery, in many cases, no fertilizer is applied to the corn crop, or only side application of nitrate of soda, as there is enough residual fertilizer in the soil. Where corn is planted not following celery, approximately 1000-1500 lbs. of mixed fertilizer per acre is applied generally before planting with subsequent applications of either high nitrogen fertilizer or nitrate of soda or nitrate of potash when the corn is knee high and/or tasseling. Sweet corn is planted in the Sanford area in 30 or 36 inch rows with the corn chopped to a stand of one per foot. Most of the corn is now shipped

in bags of 4 or 5 dozen to the bag. A yield of 200 bags per acre is considered a good yield.

While the two varieties now being most generally grown, Ioana and Golden Cross Bantam, are quite satisfactory, we have been continuing our search for still better varieties. Last season we made trial plantings of 62 varieties or strains of sweet corn, many of them on four different planting dates. Of these 62 varieties, eight were All American selections, twenty-one were crosses made by Dr. Hull of the Main Experiment Station and the balance were varieties grown in other sections of the country or crosses developed at some of the northern Experiment Stations. A good many of those tested had characteristics which eliminated them from further consideration for this area, while others showed qualities which made them worthy of further trials. In this connection let us outline briefly just what we consider desirable in a sweet corn. First, a medium tall plant, sturdy and well-rooted so as to withstand wind, one of our worst enemies; secondly, ears with tight shucks borne well up on the stalk; third, well-filled ears clear to the tip, of good length (7 inches or longer); fourth, sweet and tender kernels and fifth, better than one ear per stalk.

A very considerable number of the varieties tested fell down on the first requirement, being badly blown down and even broken off by the wind. Number three (well filled ears) was next in importance as an elimination factor. A great many varieties had poorly filled ears, some not filling out to the tip and others not filling at the butt. Of those that remained, the following were considered best:

*All American No. 21.* This produced a medium sized plant with few suckers, small cobs, light yellow kernels, well-filled ears,

ears averaged 8.35 inches in length with 12-14 rows of kernels per ear and 1.85 ears per stalk. This was considered the best variety we had by all who saw the different varieties. We have learned that this variety as yet unnamed was entered by the Associated Seed Growers as Bantam Hybrid No. 56.

*All American No. 22.* This is very similar to number 21 but the ears were not quite so well filled and are somewhat shorter, averaging 8.20 inches and having 14-16 rows per ear.

*Tri-State.* Medium to tall plants, some suckers, small cob, well-filled ears, medium size kernels, ears 8.45 inches long, 12 rows per ear, 1.6 ears per stalk.

*Evergold.* Small to medium plants, some suckers, small cob, medium sized kernels, long shanks, ears 7.87 inches long, 12-14 rows per ear, 1.5 ears per stalk.

*Goldengram.* Tall plants, no suckers, tough tight husks, large cob, small to medium kernels, ears 8.57 inches long, 14-20 rows per ear, 1.2 ears per stalk.

*Southern Cross Bantam.* Tall plants, ears close to stalk, light cream colored kernels, fairly large cob, ears 7.04 inches long, 12-14 rows per ear, 1.35 ears per stalk.

*Golden Cross Bantam.* Small plants, many suckers, golden colored kernels, well filled ears, ears 7.73 inches long, 10-14 rows per ear, 1.33 ears per stalk.

*Ioana.* Medium sized plants, few suckers, well-filled ears, light golden colored kernels, ears 7.72 inches long, 10-12 rows per ear, 1.13 ears per stalk.

*U. S. No. 34.* Which I understand has given good results in the Everglades region, did not measure up to those mentioned above. The plants were very tall, it matured late, the ears varied greatly in length, the kernels were almost white in color. The ears average 6.81 inches long, but as mentioned a moment ago, some were much longer and others much shorter.

In addition to the above several of Dr. Hull's crosses looked promising.

This season we are again planting a number of new varieties and repeats on some of those planted last year. Our crops are not far enough along to pass judgment on any of them.

In growing sweet corn in the Sanford areas there are two factors that we have to contend with which cut down the yields, first, as I mentioned previously, is the wind. During the months of March and April we have almost continuously high winds blowing either from the east or west that frequently cut down the stand of corn in exposed areas, the second factor is one that all corn growing areas have to fight, namely the corn ear worm. A few years ago the USDA developed the oil injection method for control of the ear worm. If properly applied this method will give good control of the ear worm, entering the ear through the silks, but will not control him when he gets in through the side of the ear. Another drawback to this method is that in most cases the tips of the ears are not filled out. With the advent of DDT and after one year's trials, we thought we had the answer to the question of how to control the ear worm. As we reported at the Horticultural Meeting in 1944, Mr. Russell, our entomologist, obtained almost perfect results in using a dust the year previous. During Mr. Russell's absence in the services, the writer conducted further experiments using not only various strengths of dust, but also sprays made with the water dispersible material and the emulsified material. Last year, using all of the above, we had excellent results on the first crop of corn, but the results on later plantings were rather disappointing. One reason for the unsatisfactory results may be because each ear received only one treatment and the effectiveness of the DDT was dissipated before the ear matured. Even where we found worms in the ears they were only in the tips in the majority of cases and had not done any appreciable damage. We did not, however, get any control of the worms entering the side of the ears. This year, Mr. Russell is again

making tests and on a much more elaborate scale and we hope to have some very definite information by the end of the season. Just before I left for this meeting Mr. Russell gave me the following preliminary results of the first planting of corn this year. He had the following treatments:

1% DDT dust; 3% DDT dust; 5% DDT dust; 20% wettable DDT—2 lbs to 100 gallons; the same material, 4 lbs. to 100 gallons; 25% DDT emulsifiable oil—1 pint to 100 gallons; also 2 pints to 100 gallons; DDD spray; Benzine Hexachloride spray; and injections of oil plus dichlor ethyl ether and untreated checks. Each of the above was applied at three different intervals of time, every two days, every three days, and every four days, with the first application being made shortly after the first silks appeared. A total of six applications was made on the every second day treatments,

four on the every third day treatment, and three on the every fourth day treatments. The results of the first check showed the untreated having 80% wormy ears, oil injection, 70% wormy, Benzine Hexachloride 60% wormy, for the every other day treatments, and 100% wormy for every fourth day treatments. All of the DDT and the DDD treatments showed from 0 to 20% wormy ears. As I stated above these are preliminary reports based on only a few ears from each plot. Also Mr. Russell states that the first application was made later than it should have been, which he feels accounts for the presence of worms in DDT or DDD treated plots. By the end of this season, we feel that we will be able to state definitely whether or not DDT and/or DDD can be successfully used to control ear worms in corn and at a cost low enough to make it profitable.

## GROWERS PROBLEMS IN GROWING AND MARKETING ICEBERG LETTUCE

By JOEL FIEDTKE  
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The State of Florida is proud of its climate and can easily demonstrate its great ability to grow a wide range of crops: beans, tomatoes, cabbage, celery, citrus, and many others. It would seem strange that with all these crops to choose from anyone would want to grow iceberg lettuce, which is one crop that is not suited to the Florida climate, and frequently fails to make a marketable crop. But this very difficulty is the reason for some farmers choosing to grow it. As long as there is only a small amount of it produced in Florida, the bulk of the supply for the Florida consumer must come from California and Arizona. The cross-country freight rate gives the Florida grower a competitive advantage which is not found in the crops that are grown in abundance.

Those farmers who have decided that they like this kind of risk and have had experience in growing the crop, have found that in addition to the common problems which occur to the standard truck crops, iceberg lettuce has a few additional ones of its own. This paper is addressed to farmers who are familiar with the common hazards: cutworm, wire worm, damp off, freeze, flood, etc., and will just concern itself with the troubles that are encountered only with Florida iceberg.

By far the most important is warm weather, which causes the heads to be soft. The Everglades must have unusually cool, dry weather to compete with the Imperial Valley. Most of the time even in the middle of the winter, the quality of the lettuce is irregular, and the number of marketable heads does not exceed 25% of those planted. It takes the unusually cool, dry periods to make a good crop. Last year, for example,



it was too warm for lettuce all through the winter up to the freeze of February 5th, and that was so cold that it destroyed most of the plants. The only way a grower can work toward combatting the weather is to pick varieties which are best suited to this climate.

Iceburg lettuce is subject to tipburn. This is the name given to a condition in which the internal leaves begin to die at the tip, and turn brown. A fungus, which seems to be always present in lettuce, is ready to attack these dead leaf tips and produce slime. Tipburn develops because of an unhealthy condition in the lettuce, usually due to warm or damp weather. Therefore, there is no way of combatting it. Because it forms inside the head, the packer is usually unable to know which heads have developed it, and cannot put up a clean pack. By the time the heads with tipburn reach the market they frequently develop slime. There is little that can be done to prevent this, except to create conditions which will produce healthy plants.

There is another type of fungus which occurs in warm weather. It is called bottom rot, and attacks the base of the head on the outside. This is most common on the muck. It is very contagious and spreads rapidly through a field. It seems as though badly infected elds carry the infestation from one year to the next. Since this fungus attacks the lettuce head from the outside, it would seem that some chemical could be found to check its growth, but to date none has been developed.

The marketing of iceberg lettuce has certain problems that are different from those of the more widely grown truck crops. When the Florida farmer begins to have lettuce to sell in the winter, he finds that nearly all the brokers and wholesalers have

arrangements with some California producer for a week or two in advance. They must do this if they want to assure themselves of a supply, because it takes nearly two weeks for a shipment to get to Florida. If they did not buy ahead like this, they would be dependent on whatever unsold cars happened to be rolling to Florida on consignment at that particular time. Since there are frequently no such cars, it would be foolish for the Florida buyer not to contract ahead, and have his supply en route.

This means that when Florida iceberg comes on the market it is very difficult to sell to a trade which has a two-weeks supply bought and on the road. Furthermore, the wholesalers usually remember some previous occasion when they had switched to Florida iceberg, and then found suddenly some morning that the weather had warmed up and there was no supply. It was too late to order any from California and there was probably a lot of embarrassment in not having any on hand for their retail customers who were dependent on them.

Usually it is necessary to offer the lettuce at a sufficiently large discount under the California price to overcome the buyers' fear of taking on an uncertain supply. Then, if things go well for a while, it is often possible to work the price up and reduce the discount. However, if a warm spell of weather comes along and you fail to keep up deliveries, you will probably have a lot of trouble ever getting the customer to switch to your product again. There is little that can be done to remedy this condition, except plant enough of the crop regularly to assure a supply as long as the weather does permit harvesting.

KROME MEMORIAL INSTITUTE



# NOTES ON SOME GUAVA INSECTS

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A total of 62 insect species was catalogued by Bruner, et al. (1945) as infesting the common guava, *Psidium guajava* L., in Cuba. A total of 12 insect species was recorded by Wolcott (1933) as affecting the guava in Puerto Rico. At least eight species were specifically mentioned by Ruehle (1947) as affecting the guava in Florida. It may be said, therefore, that the guava has its share of insect pests. Some attack only the leaves, others only the fruit, while still others infest the bark of trunk and branches. Owing to the importance of the fruit to Florida agriculture brief discussions of some guava insect pests with suggestions for their control are given in the light of present day knowledge.

## LEAF INFESTING INSECTS

The red-banded thrips, *Selenothrips rubrocinctus* (Gard.), is occasionally serious on guava. Defoliation and fruit russetting result from dense infestations. Spraying the infested plants with a pint of 40% nicotine sulphate in 100 gallons of water or of rotenone and derris-resinate materials, or 1% oil emulsion sprays is the recommended control.

Some of the newer insecticides, DDT, benzene hexachloride, and chlordane, have been found to control the insect. Their use cannot be recommended at this time, however, because serious infestations of scale insects may build up afterward. In one test HETP (hexaethyl tetraphosphate), one of the new phosphate insecticides, did not equal the above insecticides in thrips control.

A species of whitefly, having a tiny black spot near the center of each wing has been

infesting the guava at the Sub-Tropical Station. This is more especially true of the slathouse and greenhouse plants. This insect was identified by Miss Louise M. Russell of the U. S. Bureau of Entomology and Plant Quarantine as *Metaleurodicus cardini* (Back)

Attempts at control of the insect by dust applications of 3% DDT and 1% gamma-benzene hexachloride in the greenhouse were not satisfactory. A test was made of some of the newer insecticides in 1946 and included the following: 25% azobenzene, 3% DDT, 1% gamma-benzene hexachloride, and 3% chlordane as dusts; and of HETP as spray at 1 quart of 50% active ingredient per 100 gallons of water. The HETP showed more promise than any of the other materials. In experiments made in 1947, HETP was also promising as a control. Two other new phosphate insecticides, tetraethyl pyrophosphate and O-O-diethyl O-, p-nitrophenyl thiophosphate, were also tried. These also gave promise of controlling the whitefly. All materials were used as sprays, and were applied by means of a small, continuous pressure-type hand sprayer. The plants in the test were grown in a slathouse in pots, and were between two and three feet high at the time of treatment. All were infested in varying degrees with all stages of the whitefly at the time of treatment. The results, numbers of flies per leaf, based on samples of three leaves from each plant and eight plants per treatment, counted five days after treatment, are summarized in Table 1.

The three phosphate insecticides appear promising, having given excellent to perfect control. The next step is to try these insecticides by machine application on trees under grove conditions.

Broad mite, *Hemitarsonenus latus* (Banks), infestations, common on many

TABLE 1—WHITEFLY, *Metaleurodicus cardini*, INFESTATIONS AFTER SPRAY TREATMENTS.

Treatment material	Amt. active ingredients per 100 gals. water	Whitefly larvea, pupae, and adults per 24 leaves	Percentage control
O-, O-diethyl O-, p-nitrophenyl thiophosphate <sup>1</sup>	1 lb.	0	100
O-, O-diethyl O-, p-nitrophenyl thiophosphate <sup>1</sup>	1/2 lb.	6	95
O-, O-diethyl O-, p-nitrophenyl thiophosphate <sup>1</sup>	1/4 lb.	6	95
Tetraethyl pyrophosphate <sup>2</sup>	1 pt.	4	97
HETP 50% Vapotone <sup>3</sup>	1/2 pt.	1	99
DDT plus <sup>4</sup>	1 qt.	7	94
Check		125	—

<sup>1</sup> Obtained from American Cyanamide Company<sup>2</sup> Obtained from Victor Chemical Works<sup>3</sup> Obtained from California Spray-Chemical Company<sup>4</sup> Obtained from Hughes Seed Stores as a proprietary combination of DDT, pyrethrins, rotenone and petroleum oil materials

plants, have also been found on guava nursery stock. They infest the leaves and young stems. Leaf symptoms usually consist of crinkling and distortion. Sometimes one side of a leaf rolls under, sometimes both. A leaf may become C- or sickle-shaped, as viewed from the top or bottom. It may, on the other hand, curve downward from the tip, so that the leaf will describe an arc, or become C-shaped as viewed from the side. Russeted scar tissue is common on the under surfaces of the leaves where these pests fed. In cases of severe injury, leaves fall, growing tips wither, perish, and the plant may die.

Broad mite infestations have been observed on plants other than guava in the Sub-Tropical Station flat-house and greenhouse. They include mango, avocado, papaya, jujube, *Annona* sp., pitomba, and white sapote. The pest has a long list of host plants, including the orange, as reported by Smith (1933).

<sup>1</sup> More discussion is given to this pest because it (1) is small and cannot be studied

with the unaided eye, (2) seems to be so prevalent, and (3) is capable of considerable damage of an insidious character that may be attributed to nutritional disorders, disease, and chemical or other treatments.

The situation in which the plants are grown appears to have some effect on severity of broad mite infestations. Most plants grown in the slathouse and greenhouse are more likely to suffer from mite infestations than those grown out-of-doors. A serious infestation observed in a shaded nursery has also suggested that much shade and damper locations may be factors which favor conditions for broadmite increase.

Control recommendations would ordinarily be for applications of sulfur as dust, or wettable sulfur 10 pounds combined with either 1 1/2 gallons of liquid lime sulfur or 6 pounds of dry lime sulfur per 100 gallons of water. A Miami nurseryman, however, has reported that sulfur was not satisfactory. He reported using a rotenone, derris-resinate material, *Syntone*, as a 1-200 spray, with satisfactory control. More

work needs to be done in order to have definite recommendations.

The cotton or melon aphid, *Aphis gossypii* Glov., infests guava leaves, principally the new ones on the terminals of the branches. Control recommendations include applications of nicotine sulphate, one pint of 40% material per 100 gallons of water, or of rotenone and derris resins applied according to the manufacturer's instructions. Some of the newer insecticides as DDT and benzene hexachloride may be used for control of the aphid. They are not recommended at this time, however, because scale insects may build up more rapidly afterward.

One or more species of the leaf roller or leaf tier insects is frequent on the guava. The control suggested for these is lead arsenate as the insecticide at three pounds per 100 gallons of spray. It may be added to the important nutritional sprays of copper and zinc recommended by Ruehle (1947).

A tiny lepidopteran moth determined by Mr. Carl Heinrich of the U. S. Bureau of Entomology and Plant Quarantine as a species of *Chilocampyla*, closely related to *psidiella* Busck, a leaf miner, infests and distorts the tender new leaves. It is common but is not considered very injurious. No recommendable insecticide is recognized for this insect. It has several important insect enemies that keep it in control.

#### FRUIT INFESTING INSECTS

Some brief attention is given to a fruit infesting insect, the *Argyresthia eugeniella* Busck., which has been called the guava moth. The larva of this insect burrows into the fruit and may be present at harvest time. The time and ability required for removal of all insects from the fruit has been a serious matter in certain instances.

Recent efforts at the Sub-Tropical Station to study the biology and control of the moth have been hampered by unfavorable weather conditions, particularly by the hurricane of September 1945, which destroyed

or damaged the trees, and by the freeze of February 1947, which destroyed some fruit and blossoms.

Some data have been taken from north of Miami, on the seasonal incidence of fruit infestations. Percentages of the fruit found infested were as follows:

Jan.	Feb.	Mar.	Apr.	May	June
—	100	—	33	10	—
July	Aug.	Sept.	Oct.	Nov.	Dec.
41	—	4	70	20	—

These observations show that infestations of the moth were prevalent in varying amounts throughout the calendar year.

A small weevil, *Anthonomus costulatus* Suffr., has been found infesting guava fruit. The adults puncture the fruit and deposit eggs, and they appear also to feed on the sap oozing at the punctures. Studies are planned on the biology and control of the weevil as well as the guava fruit moth.

Plant bugs may be encountered stinging the fruit. *Sabadilla* or one of the newer insecticides may be found to control these insects. This cannot be termed a recommendation, however, because no observations have been made on the subject.

#### TRUNK, BRANCH, AND STEM INFESTING INSECTS

Ants may be found running up and down tree trunks and branches. They are likely to be attending aphids or scale insects infesting the leaves. In one grove the little fire ant, *Wasmannia auropunctata* (Roger), was so numerous that it attacked fruit pickers and caused a bit of labor unrest with some loss of fruit. An experiment was conducted to determine control measures. As a result of the experiment and also of some practical grove use a recommendation is given. The trunk and larger branches if sprayed with one pound of the active ingredient of DDT or chlordane appropriately prepared for mixing with 100 gallons of water will control the fire ant. Benzene hexachloride was found satisfactory also in fire ant control as used at one-half to

three-fourths pounds of gamma-isomer per 100 gallons of water.

*Latania* scale, *Aspidiotus lataniac* Sgn., increases were found on the tree trunks and branches sprayed with chlordane, DDT, and benzene hexachloride in the order given from most to least. An interesting and as yet unexplained observation is that the most scale insects per linear foot of the tree branches were found on trees treated with the lowest dosages of DDT, chlordane (at 1/2 lb. active ingredient per 100 gals. of water, and benzene hexachloride (at near 1/4 lb. gamma-isomer per 100 gals. water). The fewest scales were found on trees treated with the highest dosage concentrations of DDT, chlordane, and benzene hexachloride (1 1/2, 4, and 2 pounds of the active ingredient per 100 gals. of water, respectively). The scale insect counts were made 54 and 84 days after treatment and showed significantly greater increases by most treatments over the check trees. The scale increase in this instance had no serious consequence.

Leaf coverings of black sooty mold commonly discolor the lower leaves on guava

trees. Scale insects and mealybugs on branches and leaves above secrete substances that fall to the leaves below and permit the development of fungus growth. The control recommendation is to apply an oil emulsion spray of 1 1/3% oil content to control or eliminate the insects and thereby reduce or rid the leaves of the sooty mold.

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# FURTHER STUDIES OF FLORAL INDUCTION IN THE HADEN MANGO (*MANGIFERA* *INDICA* L.)

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## AN ABSTRACT

(Complete paper will appear in *American  
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Leaves of the mango produce a hormone during the fall and winter that causes the growing tissues in the terminal buds to develop flower clusters. In the absence of this substance, growth from these buds would be leafy shoots. As long as the terminal bud, or the flower cluster that develops from that bud is present and undamaged, growth is suppressed in the lateral buds. Later in the season when the hormone is no longer being produced and after the flower clusters are gone, some of these lateral buds produce new leafy shoots.

If the terminal bud or the flower cluster is damaged or removed during the fall or winter, some of the lateral buds immediately below begin growth. The hormone produced by the leaves at that time causes the developing tissues in these lateral buds to form a flower cluster instead of a leafy shoot which otherwise develop from such a bud in the late spring or summer. Even if the leaves are removed from the stem, the buds nearest the end developed flower clusters because the hormone that is being produced in other parts of the tree moves considerable distances to affect the growing buds. Movement of the hormone to the

buds in the defoliated region is prevented by a girdle through the bark and the resulting growth is vegetative.



Fig 1. The terminal bud and leaves were removed from the left branch and the lateral buds were removed from the right branch of a forked pair. Hormones produced in the leaves were transferred to the lateral buds on the leafless branch where they induced flower formation. The inhibiting effect of the terminal bud was not transmitted to the defoliated branch.



Terminal buds were removed from girdled branches of the Haden variety of mango, and all leaves were removed from the area between the girdle and the cut end at various intervals to determine the minimum length of time that was required for the hormone to influence floral development. In 1945, growth from these lateral buds was vegetative if the leaves were removed 24 hours after girdling and the removal of the terminal bud. When leaves were allowed to remain for 96 hours or longer flower clusters developed.

In 1946, an attempt was made through histological studies to correlate the length of this period with cell division. A longer period was required because drought delayed growth. Evidence from these studies indicates that the hormone does not initiate growth and cannot affect the course of the development of a bud until cell division has started.

Studies of the movement of the floral inducing hormone and the growth-inhibiting

effect of the terminal bud upon the lateral buds were conducted on forked branches. When the terminal bud and the leaves were removed from one branch of the fork and the lateral buds were removed from the other branch, lateral flower clusters appeared from the buds at the end of the leafless branch (Fig.1). The hormone produced in the leaves moved down that branch and up the leafless branch and caused growth in those buds to be floral. The inhibiting effect of the terminal bud was not observed to move into an adjacent branch. However, flower clusters appeared from lateral buds below the girdle which indicates that the transmission of the inhibiting effect was intercepted by the girdle.

Flower formation was caused by the action of the hormone in buds previously unspecialized as late as March 4, 1946. The fact is emphasized that floral initiation begins shortly before the flower cluster is clearly discernible

## EARLY EXPERIENCES WITH THE CHAYOTE

By DAVID FAIRCHILD  
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When the members of the Florida Horticultural Society see on the program the name "Chayote," and that I am giving some notes on it, I am sure there will be those who will smile and say: "Fairchild is back at his old game; trying to cram this so-called 'new' vegetable down our throats again."

Nothing of the kind. Fifty years ago I did get a lot of people to grow the chayote and thousands of them learned to like it, but a combination of the root knot and other factors which I propose to describe, discouraged them. Now, however, with the possibility in sight of controlling its worst enemy, the nematode, it seems to me that

it should be given another chance to take its place among the excellent vegetables of our southern states.

Feeling as I do that the chayote is worthy of a more extensive trial than was ever given it, I thought it would be helpful to give you some account of the experiences my colleagues and I had with it in the early days of the Section of Seed and Plant Introduction of the Department of Agriculture.

It was at Christmas time in 1895, forty-nine years ago, that I first saw a chayote arbor. I had stopped off in New Orleans on my way to the West Indies and was in the seed store of Stechler and Co. interviewing them about the various local fruits and vegetables.

They told me of a little French horti-

culturist in the suburbs who had an arbor of chayotes, so of course I went out to see him.

There were no fruits on his vine at that season, and he told me that not many were being grown around New Orleans. They were usually known as "Merlitions" or "Vegetable Pears."

I saw them again when we got to Jamaica and became fond of them and sent some home.

Mrs. Fairchild and I spent several weeks in Maderia some years later and saw them grown to perfection. In this tiny island in mid-Atlantic it seemed to play a really important role in the dietary of the people. There was a fine large arbor near the hotel where we stopped that furnished fruits for the table. There seemed to be but one variety grown; an ivory-white kind. We bought dozens of them and photographed them in fancy baskets.

We got to like them very much and I sent some to the office for we were convinced that the chayotes deserved to become a regular vegetable on the American market.

Our first efforts to grow them had already been made, at Cat Island, on the estate of General Alexander, a remarkable soldier of the Confederacy and one of the witnesses of Pickett's famous Charge. They were carried on by John Tull, who was experimenting with the General's wild rushes. For two seasons Tull grew chayotes and rushes in the abandoned rice fields on the old plantation with "encouraging results" so far as the chayotes were concerned. A two year old vine together with a three year old one produced 250 fruits in 1905.

We also subsidized a cucumber grower in the outskirts of Jacksonville, thinking he might take up their culture, but we soon saw that there was too much yet to learn about the plant and how it could be made a commercial success. It is surprising to find how many problems arise when you try to introduce and popularize a new vegetable like the chayote

As soon as we started the Plant Introduction Garden in the wilds of western Florida, cutting down great forest trees in a hammock near Brooksville to make room for it, we began to experiment with the chayote in earnest.

To begin with, there was the question of whether we had the best varieties. The chayote, *Sechium edule*, belongs to what is known as a monotypic genus; that is, a genus with only one species in it, so that there were no close relatives. But were there not perhaps many different varieties? Two, a white and a green more or less spiny form were all that had been tried in America or in North Africa, where it was grown for the French market, or in the West Indies or Madeira so far as we knew.

We ransacked the world for other sorts and discovered that the ones we already had were the usual types. However, from Costa Rica a keen observer named Carlos Werckle sent, among others, a kind that had no fibers around the seed and William Harris of Kingston, Jamaica, sent five varieties. The J. Steckler Seed Co. of New Orleans supplied us with their green, spiny sort; a large green and a large white we obtained from Puerto Rico; from Guadeloupe came five kinds we had already seen; Dr. Trabut contributed the white spiny one grown in Algiers for the Paris markets.

But it was not until Wilson Popenoe, then our Agricultural Explorer in Central America, made a study of the Guatemalan chayote and wrote them up with his usual care that we felt we had our hands on something more than merely a few slightly different varieties of the fruit.

He distinguished between the common "guisquiles" as they are called in Guatemala, which were what we had been experimenting with, and the Peruvian guisquiles called commonly "peruleros." The guisquiles were furrowed, with more or less deep sutures and might be either spiny or smooth and in color either light green,

deep green or white, and in form either pyriform or round, but the peruleros were devoid of spines, round, without sutures, and were either green or white. They varied in size, weighing from three to nine ounces. They were most attractive and their smoothness made them easy to prepare. They also had a superior flavor.

This careful work of Wilson Popenoe was done in the autumn of 1916. When his shipment arrived it showed us that we were just beginning the study of this new vegetable. The collection was carefully planted, on well-made trellises, but as often happens when species from the high mountains—in this case from an altitude of 5,000 feet—are transplanted to sea level, even though it is farther north, they grew poorly, produced only a very few fruits and gradually disappeared.

There was something peculiarly exciting to me in walking under an arbor of chayotes,—there still is. In the first place the fruits are as handsome as though they were carved of green jade or white ivory. I can never keep my hands off them they are so clean and so pleasant to handle. If the plant is well grown and vigorous, hundreds of them hang down from the canopy of green leaves and the picking of them is easy.

The tendrils, a foot or more in length, are so sensitive that they will curl about a pencil if you whirl it under their tips, and once they have made a turn around it they begin that cleverest of the tricks of a tendril which is to twist a short portion of the center of itself so that one half becomes a right-handed and the other a left-handed spiral and this shortens the tendril and raises the branch close up to its support.

When the small yellow female flowers are fertilized and the miniature fruits have set, they grow with astounding rapidity and it seems only a few days before they are ready to pick.

Fabulous were the stories of the produc-

tivity of the chayote. Not until we had the authenticated account of one vine that climbed, in twelve months from seed, up over a porch, half way round the house and over some telegraph wires into two oak trees and, beginning to bear in August, produced before frost cut it down in December, over four hundred fruits, did we believe any of them.

Later on, Mr. Pierpont of Savannah, Georgia, topped all the other records with two plants which, in the rich alluvial soil of the Isle of Hope, covered trellises nearly an acre in extent and bore over 1500 fruits in one season.

One of the curious complications, which I believe is rather a unique one, in growing the chayote, comes from the fact that its fruits have only a single large seed and that this seed is imbedded in the flesh of the fruit in such a way that you have to plant the whole thing—fruit and all. This fruit as it shrivels up and decays furnishes the nourishment for the young plant. In planting, the whole fruit is set in the ground so that its large end lies deepest in the earth and the whole is covered with two inches of soil.

Our experiments at Brooksville and elsewhere, over which Robert Young presided, taught us how to grow the vine and handle it in the various regions of Florida, and those of David Bisset in Savannah showed us how the plant could be protected from freezing in Georgia by putting a box filled with straw over the crown, leaving air for the plant to breathe but shutting out the worst of the cold.

Planted in spring when the danger from frost is passed, in a hill made in well-drained, rich garden soil, one fruit will grow before autumn into a vine requiring a strong, well-made, head-high arbor, for as I have said, it is a rampant grower.

Fifty pounds of well-rotted, barnyard manure, supplemented on poor soils with a pound and a half of any standard commercial fertilizer that is rich in potash, will

keep the vine growing if the other conditions are favorable. Mulching is necessary in dry weather, for the plant is not accustomed to drouths, and in irrigated countries a good supply of irrigation water is always required. Since the vine is a perennial it need not be planted every year although after four years plants usually run out and should be replaced by new ones.

My friend Homer Skeels and I got a good deal of amusement out of growing this tropical vegetable in the latitude of Washington. When the seasons were long we got a modest crop of rather small fruits of good quality, but we could never count on having a long autumn without killing frosts, and this uncertainty proved a "limiting factor" as they say. Even when the fruits were started in boxes indoors and set out as soon as possible in the spring, preferably in cool weather, the growing season was too short.

It was also a good deal of a problem to keep the chayotes we wished to plant out in the spring from sprouting during the winter, for they had a tendency to do this whenever there was any considerable change in the temperature about them.

This difficulty was in our minds when one autumn day Mrs. Fairchild and I took our little children to the Luray Caverns which were then run by their owner, Col. Norcott, a man of very considerable imagination.

As we were walking through the caverns he remarked that the temperature did not change more than a degree or two, summer or winter; always about the same, always a practically saturated atmosphere with the temperature around 54.

I told him of our problem with the chayote and he suggested we send him a crate of the fruits to store in the cavern. He would watch them and give us a report on their behavior. As I recall it, the experiment was a success; the fruits showed little or no signs of germinating. His reports will be found in the records of the office. But

we were in no position to follow the matter up commercially. We had no tonnage of chayotes of course.

We were satisfied that changes in temperature induced germination in the chayote fruits. How far this applies to root or tuber vegetables, I do not know. Since most fruits have seeds which wait for the decay of the fruit-flesh before they germinate, this experiment may have a certain significance.

There was a feature of the chayote which, perhaps owing to our short seasons, never took on any importance in our minds. I refer to the large fleshy root which, among the Indians of Guatemala is considered a valuable starchy vegetable. It is boiled and eaten much as is the yam or sweet potato, and has a flavor of its own which one easily becomes accustomed to and learns to like.

Once we had learned how to produce the fruits of the chayote it seemed as though our problems had only just begun. We had before us the most difficult of all; the problem of getting people to eat them.

It was easy enough to prepare them for the table and when boiled they taste something like a squash or a cucumber or a vegetable marrow. I think the chayote lends itself to more different recipes than does the squash because of its firmer, more agreeable texture. Chayote salad, chayote fritters, chayotes fried, creamed, stuffed, baked and made into pickles; these are some of the ways chayotes can be eaten. Even a rather close approach to apple sauce can be made with boiled and mashed chayotes flavored with fruit juices and spices.

So it was up to us to cook the chayote and test it on ourselves and our friends in as many ways as we could devise and in doing this we had some interesting experiences. Naturally I was desirous that my superiors in the Department should take a fancy to it and help create a market for it.

I recall serving creamed chayote at a luncheon we gave for Mr. and Mrs. Houston

when Mr. Houston was Secretary of Agriculture. We watched with curiosity and satisfaction as Mr. Houston ate it, only to have the whole effect vitiated by a remark of Mrs. Houston's that her husband never knew what he was eating.

Mr. Graham Bell took a liking to the chayote and served it at one of his "Wednesday evenings," which gave me a chance to discuss its qualities. He suggested that it would be a good vegetable to try on the guests of the National Geographic Society at one of the Annual Banquets which in the earlier days of the Society were a feature of Washington life.

The Society printed a folder with illustrations describing it and Mr. Haight, the then manager of the Willard Hotel, took the trouble to interest his Chef in it and it was well served; boiled, in cubes, with a white sauce. Everybody ate it and seemed to like it. I had many compliments and still more enquiries as to where it could be gotten and if it were on the Washington market. Libby, Libby & Co. discovered they made good pickles and wanted to know where they could get carload lots.

Of course it was not on the market. We were trying to interest growers to plant it, but no grower had yet had the temerity to put out so much as a dozen acres of it on the gamble that he could sell it at a profit without advertising, especially when he knew very well that as soon as he did make a profit, others would go into the raising of them and undersell him on the market, taking advantage of the advertising his success had given it. This was the joker in the whole game of starting a new plant industry. Who was going to start it? With no protection of any kind against miscellaneous competition, no way of preventing the market being flooded with inferior fruits which had the right to be sold under the same name, what man of capital would be interested in backing the gardener who was willing to grow chayotes?

As no less a speculator in new things than Glenn Curtiss once said to me when I

suggested he grow dasheens: "Lets try something easier, Fairchild." He tried what he thought was easier and built the town of Hialeah, getting hundreds of people to gamble in real estate with him.

I cannot remember now how many years we of the Office kept our propaganda going, for in April of 1917 the First World War came with its upsetting new programs put up to us and, although the stream of new plants coming in did not slacken, much experimental work had to be given up and propaganda for the chayotes was curtailed when that for Dehydrated Vegetables had to be started.

But scattered here and there through the South there remained some adventurous planters who still persisted in growing it. In 1920 there were some 1275 on our lists who had received chayotes to experiment with and we hand-printed and distributed widely thousands of illustrated leaflets showing how to grow and how to cook the vegetable.

Most of them however lost their seeds—ate them or fed them to stock—and when in 1929 I tried to get some chayotes to grow on my own place in Florida it was with difficulty that I could find a few fruits with which to start.

These grew however and I gave away many fruits and some of them came to the attention of my friend Col. E. C. Prentice, a retired Army officer, known for his pioneer work in aviation. The colonel took up their culture with vigor and for two years sold all he could produce, on the Miami market.

After his death Messrs. Hubbell and Stambaugh grew beautiful chayotes under cloth shade, but I have seen no printed account of their experiments and chayotes are seen much less often in the market.

In DeLand, Florida, several pioneers took up their culture, among them an expert accountant, Mr. Dickinson, who told me the following story:

Enough men became interested in chayote

growing around DeLand to produce a large crop. What to do with it was the question. Someone suggested that they combine and ship a carload to some Northern city. Some other person said he knew a dealer in Chicago who would handle a carload, so they filled the car. Just as they were about to ship, a wire came from the dealer saying he could not or would not handle so many.

The car was already loaded and since someone else had the name of a Philadelphia dealer it was decided to ship to him, with the result that was to be expected. The dealer found himself in possession of a white elephant.

"How do they expect me to sell an entirely new vegetable which has never been advertised and which nobody ever heard of? There is no demand for the thing. What shall I do with it?" And a carload of delicious chayotes was dumped.

"What's the use of growing something for which there is no market?" was the universal question.

It is customary for people to look upon any new vegetable as unimportant until it gets into common use where they live, and they cannot realize what this chayote means to the inhabitants of Guatemala; to Guatemaltecos the guisquile is one of the most valuable vegetables grown.

When in 1941 Mrs. Fairchild and I visited the mountain region of Guatemala we saw piled up in the picturesque markets great heaps of guisquiles and peruleros which Quiche Indians had brought down from their cornstalk towns on the slope of the Volcan de Agua. Maria served them to us in Casa Popenoe in Antigua with a butter sauce and we realized that we had formed a very inadequate idea of the delicate character of this vegetable we had grown years ago; that here there was a real and important problem for some good horticulturist; the breeding and selection of these strikingly different forms of chayote.

We visited the town of Santa Maria de

Jesus near the cinder cone of the volcano and saw every little house embowered in a vine of the chayote from which hung hundreds of fruits in easy reach of the "cook" whose "kitchen" was only a step away. Little children in pretty hand-woven dresses stood about, eating the small green peruleros which had been boiled and salted for them. For how many centuries these Indians have been eating guisquiles and peruleros with their corn, someone may sometime discover in the fossilized remains of the kitchen middens of their ancestors.

Of course the chayote is not free from diseases. Plant lice attack it, but they can be controlled by nicotine sulphate sprays. Melon and pickle worms sometimes feed on the fruits and have to be fought with arsenical sprays. When the soil conditions are not quite to its taste a fungus disease sometimes attacks the leaves and Bordeaux mixture had been the best remedy for this. But the most disturbing, even tragic factor, was the root knot disease. In the course of a year or so the vines usually became infested with this, the greatest curse of gardening in southern latitudes, and it was necessary to shift the plantation to new ground, and plant again the new spot, which is a discouraging procedure.

There have now appeared upon the scene new, and I am assured, very efficient means of rendering a plot of ground comparatively free from nematodes. I refer to the use of Dow Chemical Co.'s "Dowfume," Shell Chemical Corporation's "D-D" and "Larvacide," a product of Innis, Speiden & Co.

This discovery will, I hope, give a new impetus to chayote growing and perhaps some other amateur will originate sorts better suited to Florida conditions than the ones Col. Prentice worked with, and which may have as fine a flavor as the peruleros.

The slow growth in popularity of the chayote will hardly satisfy anyone with a manufacturer's point of view. He will speak of the radio, good roads, modern automobiles as having all become necessities during the years in which the chayote has been so

slowly establishing itself in the taste of Americans. But I am not convinced that these things are comparable. Consider the millions of dollars that have gone into the advertising of any manufactured product with the almost complete lack of any put into attempts to push the chayote and you become aware that a comparison is impossible. I venture the statement that more money was spent in advertising instant postum than was expended by the Government in the introduction of new foreign plants for the whole country during the past 32 years.

It is slowly and tediously that a new vegetable such as the chayote must work its way into the good graces of a people and earn its right to be classed as an established table vegetable on their menus.

A dealer in one of our big cities found himself burdened with a large shipment of chayotes which he could not sell under their strange name but when he called them "Trellis Squashes" he sold them readily.

Perhaps people hesitate to buy a vegetable the name of which they don't know how to pronounce.

## RESEARCH IN TROPICAL HORTICULTURE AT THE UNIVERSITY OF MIAMI

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Ever since the establishment of the University of Miami, its trustees and officials have been cognizant of the important role that agriculture, and especially horticulture, plays in the economic and aesthetic life of the South Florida area and tropical America. Even though they have been over-busy in building up a material as well as a first-class scholastic institution, they have not lost sight of the fact that teaching and research in tropical agriculture are important contributions of a university so situated climatically and geographically as is the University of Miami.

There is no place in the United States better situated to undertake the establishing of a well-rounded educational center for research and teaching in tropical agriculture than the University of Miami. Miami is 600 miles farther south than San Diego and approximately 80 miles from the Tropic of Cancer. It is 280 miles farther south than Cairo, Egypt, and has the same lati-

tude of Central India and Arabia. It is so located that it is easily accessible by boat, rail, and air to all the tropical American countries.

Dr. Wilson Popenoe, who is an expert on tropical and subtropical fruits, has this to say concerning research on tropical fruits: "The thickly populated countries of the temperate zone must look more and more to the tropics to supplement their own food resources by direct supplies made possible in ever-increasing measure by ever-improving means of transportation. Many fruits of the tropics, not all of them so important, yet all valuable in degrees in the dietary of the race, must be grown in ever increasing quantities, not only to supply temperate zone markets, but also, and even more important, to enable the native populations of the tropics to obtain abundantly and cheaply this most wholesome source of human energy."

Some of the staff of the University of Miami have already made valuable contributions to horticulture. Dr. Walter M. Buswell, curator of the herbarium, assisted by Mr. Roy C. Woodbury, has built up a splendid herbarium of tropical and subtropical

horticultural plants of the American tropics. It is housed in the New Botany Building and is being extended to include those plants from other countries of the Caribbean area as well as those of South Florida.

Dr. W. T. Swingle and Mr. Frank Vennig have done a fine piece of work in unscrambling some of the confusion which has existed regarding the accurate determination of species of the many plants which have been introduced into South Florida. Specific information has also been determined which makes it possible to estimate the value of these plants as possible root stocks, scions, or breeding material. At the present time plots are being set up in which these relatives of citrus are to be used as root stocks for our commercial citrus varieties.

Dr. Taylor Alexander, Chairman of the Department of Botany, has conducted research for the past three years on developing varieties of food plants which would produce during the extreme summer period in South Florida. Progress has been made particularly with tomatoes and corn. Over one hundred varieties of various vegetables have been tried in the natural soils of this area as well as in the field of hydroponics. Under this head such phases as best nutrient soil solutions, insecticides, and fungicides as well as the light requirements are being investigated. This project is being continued and expanded.

Dr. J. J. Ochse, Professor of Applied Tropical Botany, came from Java where he was in charge of the Agricultural Experiment Station. He is an international figure in the horticultural field, being an authority on tropical and subtropical plants. He is author of many bulletins and several books on tropical and subtropical fruits and vegetables. Dr. Ochse is teaching several courses in tropical horticulture, as well as conducting research on propagation and pollination of tropical fruits and culture of new vegetables for the tropics.

Dr. M. J. Dijkman, Associate Professor

in Tropical Botany, has recently come to the University of Miami from the Dutch East Indies where he was associated with agricultural research and extension. His specialty is plant breeding of tropics, which subject he will teach and is also planning research along this line.

Mr. Frank J. Remold, who is professor of Ornamental Horticulture, is teaching ornamentals and landscape gardening. He is also doing research along the line of propagation and nutrient requirements for tropical ornamentals.

Plant research on the tropical and subtropical fruits, especially with regard to their commercial adaptability to South Florida and contiguous areas offers a field of work that is almost endless. We have planned to approach these problems with a high degree of selection. Several research agencies such as the Subtropical Experiment Station of the University of Florida and the United States Department of Agriculture have already contributed much to solving the many problems facing the grower of tropical and subtropical fruits. The field is so vast that there need be no duplications in efforts. We are concerned specifically with tropical and subtropical horticulture. We have already established projects in which the results of field studies can be closely coordinated with the handling, packaging, processing, storing, nutritive values, and by-products of the same fruit. In short, the aim or end result of every field experiment is a finished food product ready for sale as it leaves the laboratory, or pilot plant. Our aim is to find new and better food products from tropical and subtropical fruits and vegetables and to find ways of producing and handling these tropical crops more economically.

We have set up a Tropical Food Research Center consisting of an Experimental Farm and a Food Laboratory. This unit is located on the South Campus of the University of Miami, formerly the Richmond Navy Air Base, which is 10 miles south of



the Main Campus in Coral Gables. The Campus consists of 2080 acres of which 350 acres have been set aside for plot experiments. Present plans call for the development of 15 ten-acre plots during the next several years. The ground will be broken on the central plots within the month. The plot planting of 10 acres to each fruit will be on a large enough scale to simulate commercial plantings. Protective housing for propagation material and irrigation for all blocks are being provided. Access roads will surround each block for ease of work, and will make inspection easy to the public.

In order to keep the field studies within reasonable bounds, the work will be confined principally to fruits of commercial importance such as avocados, Persian limes, mangoes, papayas, pineapples, and some of the little-known introduced fruits which show promise of becoming of commercial value such as lychee, guava, sapodilla, white sapote, yellow sapote, and the annonas. The experimental work will be in the field of nutrition including both major and minor plant nutrients, varieties, propagation, plant breeding, root stock studies, and improvement of cultural methods including harvesting methods.

The Food Laboratory is also located on the South Campus. In the hospital building are located a number of offices, a food preparation laboratory, a food packaging laboratory, a bacteriological laboratory, and two large chemical laboratories equipped for bio-chemical and food composition research. We also have a large food processing room in which research of pilot plant proportion can be set up. It is tiled throughout and well-equipped with such things as stainless steel steam blanchers, steam jacketed kettles, peelers, grinders, and other food processing equipment. We also have several cold storage rooms with controlled temperatures and humidities in which we are conducting our storage and consumer package investigations. We have two fast freezing boxes and a large sub-zero freezing storage room for bulk storage. Our build-

ings are exceptionally large and will allow for ample expansion as additional space is required.

There are many technical and specific problems in the pure science field that need to be investigated, which phases of the work will be given to graduate students. These can be either in the field or laboratory. Graduate work will be given in several fields under the heading of tropical horticulture. Even though we are in the beginning, primarily interested in research, it is the plan to add additional classes each year and thus build up a splendid educational center in tropical agriculture.

As mentioned above, it is our intention to coordinate our field and laboratory work as closely as possible. Since the work is now just being initiated on the plots themselves, it will be several years before results will be obtained with regard to mature crops. However, cooperative investigations will be conducted in the meantime on already-established groves. Research is already in progress on the packaging, processing, preservation, nutritive value, and by-products of commercial crops as are now grown in this area. We know that this information will be of value to the grower, packer, and will provide additional information pertaining to the preservation and utilization of their existing crops, and will also provide valuable leads as to variety, selection, and cultural practices.

We are fortunate in having the Fairchild Tropical Gardens and the United States Plant Introduction Garden so close at hand. They have done a splendid job of introducing tropicals from all over the world and have found ways and means of growing many of these under our climatic and soil conditions. After proving that a fruit will produce well here, there is a big gap between the growing of several plants to growing a commercial-sized planting. Composition and nutrient values must be obtained and ways of handling, packaging and processing, as well as by-products, must be investigated. We recognize the excellent

work which is already being conducted in this and related fields by such organizations as the Subtropical Experiment Station, the Bureau of Plant Industry of the United States Department of Agriculture, and other state, federal, and private institutions. The field of research in tropical horticulture is endless.

There are many problems which confront us due to the numerous fruits and vegetables which are adaptable to this area and

the vast difference of this region to those of any other in the United States. We shall not solve all of the problems we now see in the many years ahead and with each year there will be new problems appearing constantly. We do hope, however, that we can take our stand along side the other research groups and have a large share in the building of new industries and in creating better living for this fruitful area.

## NOTES ON THE PROPAGATION OF THE SYMPODIAL OR CLUMP TYPE OF BAMBOOS

MILTON COBIN

*Fairchild Tropical Garden*

Coconut Grove, Fla.

The Bamboos botanically reputed to be the oldest living grasses of our world flora play a major role in the plant life and economy of the Orient, India, Asia and parts of Latin America. It is estimated at present that there are in the neighborhood of one thousand described species and varieties of Bamboo (5).

The flowering and fruiting of Bamboos is a somewhat rare phenomena in most species of these grasses. In many species accurate data on flowering and fruiting periods are not available. Records of other species indicate that it is common to have intervals of thirty, fifty or seventy years or more transpire between one blooming period and the succeeding flowering period.

Altho a small number of the known bamboo species have been introduced into Florida they have nevertheless been extremely slow in coming into the prominence they deserve in the Florida landscape.

In South Florida one sees a scattered specimen or group of specimens of several different species of bamboos attesting to

the adaptability of a number of these majestic grasses to our soil and climatic conditions.

The largest collection of exotic bamboos to be seen in Florida is located at the U. S. Plant Introduction Garden, Coconut Grove, Florida, of the U. S. D. A. These introduced bamboos have proven to be among the best wind resistant exotics ever grown in Florida.

The rare flowering and fruiting habit of bamboos requires that vegetative propagation be resorted to for the production of these bamboos.

It might be of interest to mention here that wide variation in vegetative character and habit has been noted in several species of bamboos grown from seedlings. Such seedling variation can be readily noticed by inspection of *Bambusa tulda* Roxb. and *Dendrocalamus strictus* Nees, grown in Florida that were raised from imported seed.

Of three separate seed introductions of *Bambusa tulda* introduced by the Bureau of Plant Industry and at present being grown in Puerto Rico B. P. I. No. 22002 introduced by Dr. David Fairchild in 1907 from India is of exceptional economic importance and

extremely ornamental while the other seedling strains are considerably inferior both from an economical and ornamental standpoint. *B. tulda* No. 22002 has erect straight culms that are over 50 feet tall with internodes that are up to two feet in length while the other strains have culms that rarely exceed thirty feet in length and these normally check at the nodes during growth, also, the internodes are short being usually about a foot in length and the culms are consistently crooked.

In general bamboos can be classified as belonging to either of two types: (5)

1. The type usually native to the temperate zone having an indeterminate rhizome character (*Monopodial*) which form the running bamboos, as contrasted with

2. The type usually native to a tropical or semitropical habitat having a determinate rhizome character (*Sympodial*), which produce plants having a clump habit

As far as the Monopodial or running type bamboos are concerned there is not any major problem in the vegetative propagation of these plants. Quantities of sections of rhizomes can be easily procured from which new plantings can be readily established. (3)

However the situation has been relatively difficult when attempting to propagate quantities of the Sympodial or clump type bamboos using rhizome material, for it requires the removal of a whole culm or more for each piece of propagating material.

A number of vegetative propagation methods have been and are being used for the propagation of the Sympodial or clump type Bamboos, (1) which are far from satisfactory as they are extremely laborious and costly in both time and money.

Attempts at rooting culm cuttings of several nodes in length or a number of desirable species have yielded extremely low percentage of takes. Such cuttings are usually extremely bulky and pose a real

problem when transportation of any distance is involved.

Of the various methods of propagation that have been used namely, culm stumps (offsets), two-node cuttings, air layering, and buried whole culms, the first and last have been favored as being the most efficient yet these have decided limitations.

As in the culm cutting method we encounter in the culm stump method a serious limitation in the transportation of the bulky propagating material of the larger species where the average culm stump or offset often weighs as much as twenty pounds and usually takes one man-day of labor to dig and prepare five such offsets. In addition when this method is employed only one plant can be obtained from each culm. In the buried-whole-culm method the labor costs are even higher than that encountered when propagating by the culm stump method and it is most impractical for use where transportation over any distance is required. The proponents of this method of propagation state that it is favoured because more than one plant can be obtained from each culm. However, observations made where this method was being employed indicated that this additional increase in production was not always obtained.

During 1943 while the author was engaged as Horticulturist at the Federal Experiment Station at Mayaguez, Puerto Rico, Dr. F. A. McClure, then Research Associate of the Smithsonian Institute, Washington, D. C., and the foremost American authority on Bamboos, visited the Experiment Station. Dr. McClure stated that he had successfully propagated *Sinocalamus Oldhamii* (Munro) McClure while in the Orient from basal side branch cuttings.

Subsequent observations made in the field on thirty odd species and varieties of introduced Sympodial or clump type bamboos growing at the Federal Experiment Station showed that most of these had a common characteristic in their morphology namely, that at the base of the developed culm side

branches a number of foreshortened nodes are to be found and that root initials are usually present at these nodes. (2)

Over 100 side branches of *Sinocalamus Oldhamii* P. I. No. 76496 were cut with a hack saw flush with the culm. The tops of these side branches were removed leaving from one to three normal nodes above the foreshortened nodal base. These untreated cuttings were placed in a sand propagating bed and within sixty days practically 100% of the cuttings had developed vigorous fibrous root systems with roots measuring up to 18 inches long. During this period side shoots developed from the normal nodes above the sand level. Three months from the time the cuttings were taken basal shoots emerged from below the sand level, these new culms originating from the dormant buds of the foreshortened nodal area of the basal side branch cuttings.

Similar results were obtained with basal side branch cuttings of several other bamboos.

Cuttings of *Bambusa vulgaris* Schrad. and the variegated yellow culmed variety, *B. vulgaris* Schrad. var. *vittata* A. Riviere and *Gigantochloa verticillata* (Willd.) Munro, were rooted with as much ease as those of *S. Oldhamii* the majority of which produced new young culms within sixty days. In some of the cuttings of *G. verticillata* new culms 6 feet tall were produced within ninety days of placing the cuttings in the propagating bed.

In these initial trials rooting was obtained with basal side-branches of a number of other species of sympodial type but with far less success than the above species.

*Bambusa textilis* McClure a relatively hardy bamboo from southern China produces clumps that have a striking erect habit and the native culms reach a height of 40 feet or more. Under ideal growing conditions the culms of this species do not normally produce side branches much below 15 feet from the base of the culm. The side branches have a number of foreshort-

ened nodes at their base, but the root initials are not well developed as in the above mentioned easily rooted species.

I recently observed a vigorous healthy clump of this species of bamboo at the B. P. I. Introduction Garden at Chapman Field the growth habit and character of the side branches were similar to those observed in Puerto Rico.

A clump of this same *Bambusa textilis* planted at the Fairchild Tropical Garden in 1943 has been under observation for the past few months. This clump is not in good vigour in part attributable to the lack of adequate drainage of the planting site. The interesting feature displayed by this plant is that an abnormal amount of side branches have been produced on almost every culm of the clump and that these side branches are developed on almost every visible node above the ground. The root initials at the base of the side branches are not only well developed, but during the heavy summer rains experienced this season, these root initials in some cases developed into roots measuring an inch or more in length.

It would appear highly probable that thru proper physiological stimulation the root initials found on the culm side branches of all sympodial type bamboos could be made to develop fully.

The side-branch method of propagating several species of sympodial bamboos is the most practical method. Its advantages over other methods are several:

1. Small amount of stock material yield large quantities of propagating material. After removal of a side branch, several dormant buds at the same node may develop into shoots for future propagating material.
2. Both labor and time involved are reduced considerably.
3. Propagating material can be easily transported over long distances.

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## WRAPPING AIR-LAYERS WITH RUBBER PLASTIC

By WM. R. GROVE  
*Lychee Orchards,*  
Laurel

The lower limbs of some trees and plants occasionally lie on the ground. Under appropriate soil and moisture conditions many of these limbs will strike root and start new plants, especially when the limbs have been scarified.

Many generations ago the Chinese decided to utilize this rooting ability by taking the moist soil up to the limbs, scarifying or removing the bark from a small section of the limb at the point where the new roots were to be formed. The point selected should have been and probably was just below a node.

The soil was doubtless wrapped around the cut and tied in place by using leaves and straw. To keep the soil wet over the period of from three to ten weeks required for the roots to develop to a length of one to three or more inches was doubtless then, as now, the real problem.

In the modern method when the young roots begin to show through the wrapping of moss or dirt, the limb is cut off just back of the new roots, kept in a moist and reasonably dark atmosphere for perhaps two or three weeks, then gradually exposed to more light so that within a few weeks the young tree will stand the full sunlight.

That process, variously known as Chinese air-layering, gootee layering (India) and marcottage, has long been used by nurserymen and others in plant propagation. One of the most serious drawbacks to this method has been the necessity of frequent watering to keep the layered limb alive until suitable new roots could be developed.

While the above process was the one prevailing for many centuries, the introduction of rubber plastics, having the properties of holding water, but permitting the passage of respiratory gases, offered an opportunity to develop a new method of wrapping the layers so that they would produce new roots before the water within the layers had become exhausted or sour. This means that a limb of a lychee, hibiscus and many other varieties of plant life can be girdled or scarified, encircled with sphagnum moss, soil or other rooting material in the usual way, then wrapped in a sheet of the rubber plastic, tied securely, preferably with rubber bands, and then forgotten until adequate roots can be observed through the plastic, when the branch is cut from the tree or shrub, the plastic removed and the newborn tree potted or planted. This eliminates the expense incident to watering the layers.

My first experiments with the plastic wrapping were with what is known as pliofilm but it failed by disintegration before the lychee roots could be formed. I then used Vitafilm which is a heavier plastic with the

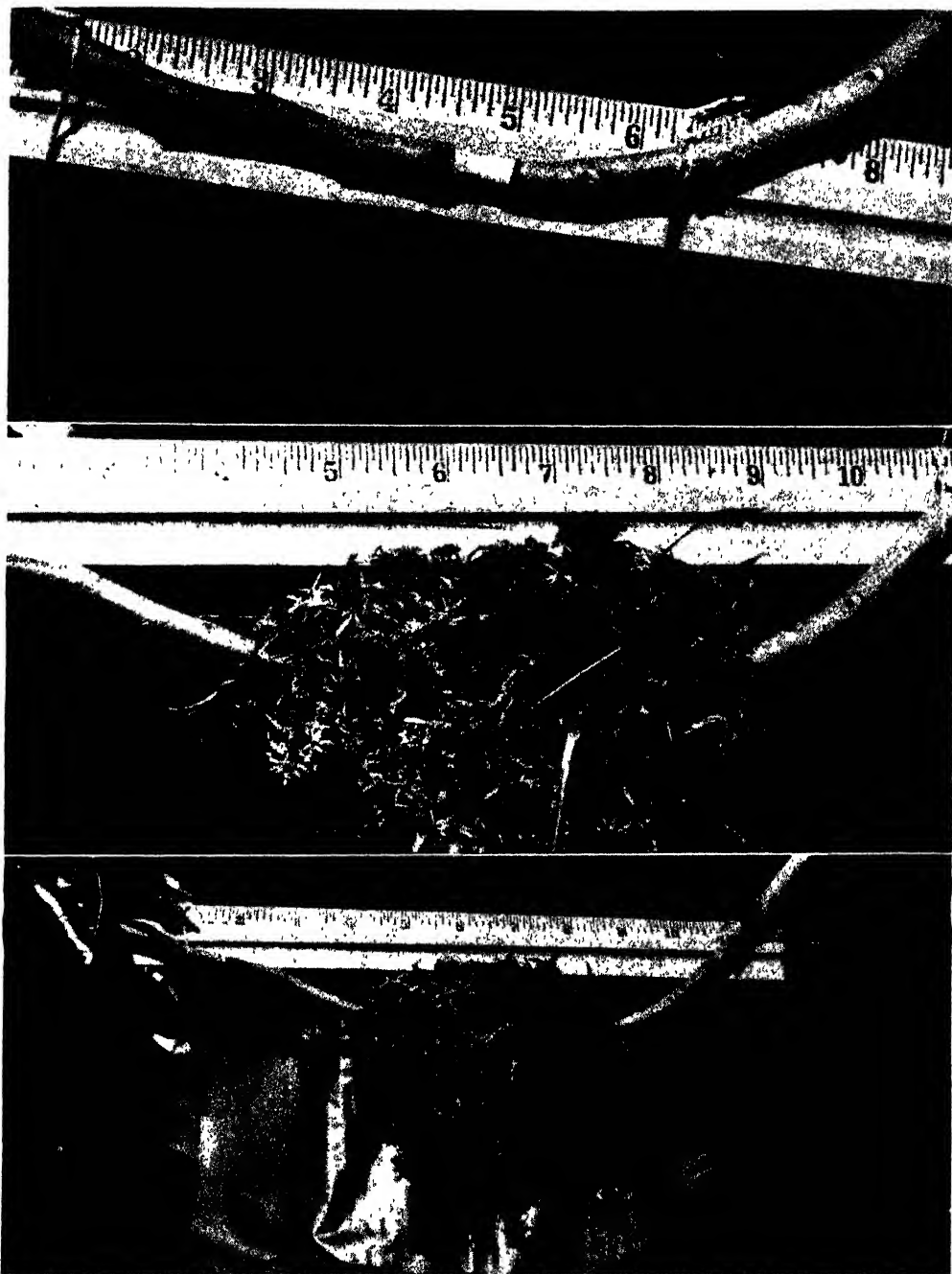


Fig. 1. Air layering the lychee—showing the relative size of bark removed. Fig. 2. Air layering the lychee—loose sphagnum moss placed over the girdled area. Fig. 3. Air layering the lychee—showing the size of the plastic sheet required.

same properties as the pliofilm, ie: holding the moisture but permitting the passage of air. Plioilm, or the other light plastics, may be found to be suitable for plants that may be quickly rooted, such as hibiscus tiliaceous, which requires only twenty days.

Experiments have been made with white, black, green and red colored plastics and experience may prove one or more of these to be better material for wrapping the layers than that I used in most of the 1947 production, which was the clear vitailm, gauge 250 P-9, manufactured by the Good-year Tire and Rubber Company.

To more clearly illustrate the method, I present photographs showing in detail the various stages of the process, using the lychee, which requires more time for rooting than most plants, as the subject.

The Lychee layers, wrapped with the plastic, do not root as quickly as when no covering is used, doubtless due to the slower process of breathing, but the great saving of labor and trouble of watering much more than compensates for the delay.

We observed that on a hot day the layers that were exposed to the sun became quite hot to the touch of the hand. We opened some at this stage and the moss seemed quite warm. However, we could charge no loss directly to this cause. We layered some sapodilla limbs in May and took them off in mid-October, with good roots. So in five months the moss had not become sufficiently overheated to prevent good rooting.

This year we used dried sphagnum moss from the north instead of fresh moss and did not find it as satisfactory as the local fresh moss.

There were a number of adverse factors which affected the layering this year, so it is difficult to precisely appraise the advantage of the method. For instance, the first lot of vitailm was lost in transit, which delayed for thirty days the start of the layering.

We like to start layering lychees soon after April 1st and not later than May 1st

to be certain that the roots are well formed before the hurricane season.

Colored girls were taught to do the work of cutting the bark and wrapping the layers. At first we tied the moss on with a waxed string. Later we developed the method shown by the photographs using no string, but tying the wraps only on the outside of the plastic, using rubber bands instead of string. The plastic wrapping is a faster process than our old style wrapping.

Another item is the pecking of holes by birds. In our operation of somewhere near 13,000 layers of all kinds, I am quite certain we did not have more than a dozen of such occurrences. Perhaps there are so many fruits and berries on the place that the birds do not have to explore for food.

We had two hurricanes in one week before all the layers were ready to be cut off. The shaking in the wind did not help them.

The labor trouble and the hurricane damage would have applied to layers wrapped in the old style, for we used to tie the moss on securely, and then put on a wrap of tar paper open at the top for watering and with a small hole in the bottom for drainage.

The average size of the plastic wrapper used on the smaller branches was about 9 1/2 x 11 inches or about 100 square inches per wrap. The cost per wrap including freight, was less than two cents. The vitailm was shipped in rolls of about 100 lbs.

While the vitailm used in our work is no longer available, the large rubber companies are manufacturing a still heavier product that costs considerably less per pound, but will somewhat increase the cost of each wrap. The cost will still be around two cents each. I have tried the heavier product and found it satisfactory.

I have used commercially the method described and have applied for a patent. I am using it on many items other than lychees and it appears to be a successful method on any plants that can be air-layered.

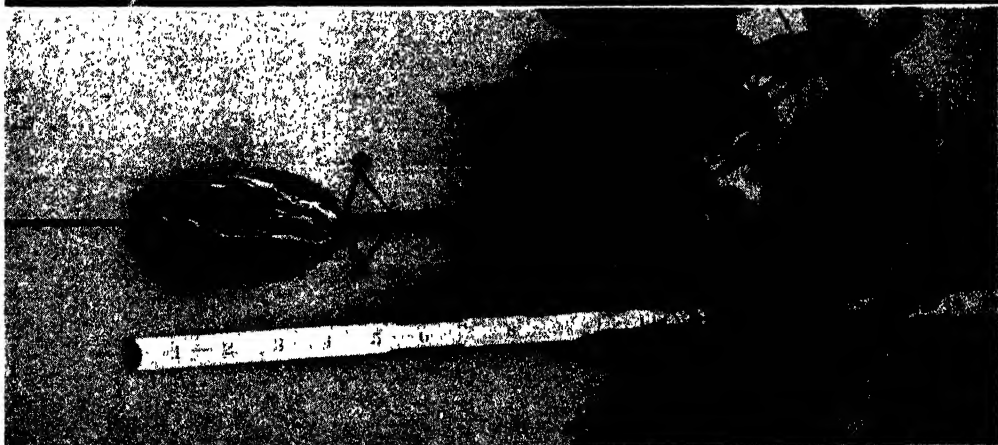
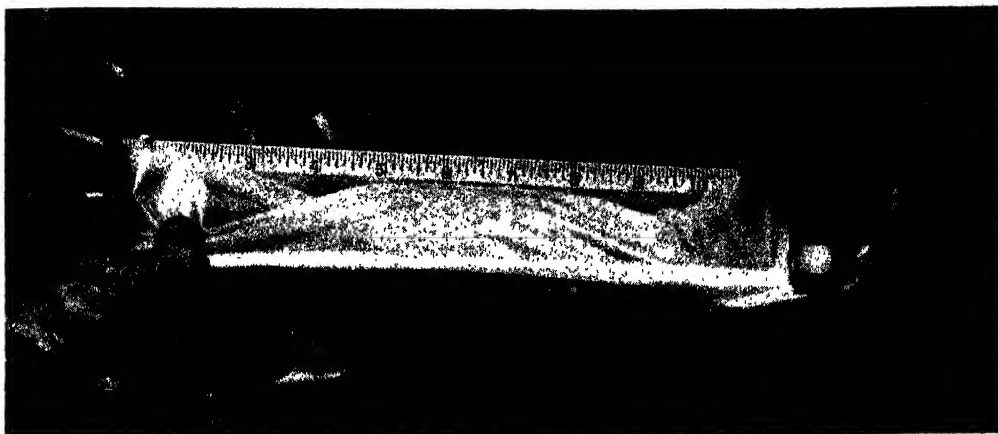


Fig. 4. Air layering the lychee—the longitudinal wrap. Fig. 5. Air layering the lychee—the wrap completed and tied with rubber bands. Fig. 6. Air layering the lychee—roots developed and wrap removed; the air layer detached and ready for planting in soil



# REPORT OF SUBTROPICAL FRUIT COMMITTEE

GEO. D. RUEHLE  
Chairman

At the last meeting of the Krome Memorial Institute held in Miami in May 1946, the group voted favorably on the suggestion to form a Subtropical Fruit Committee to register new and desirable varieties of all types of subtropical fruits other than citrus. In the discussion prior to the actual voting, the group expressed the opinion that the new committee should take over the work of the then practically defunct Avocado Variety Committee and simply expand that work to include other fruits. Acting on instruction from the group, your Chairman has appointed the following individuals to the Committee:

Mrs. W. J. Krome, Homestead.

Mr. Wm. R. Grove, Lychee Orchards, Laurel.

Mr. T. T. Sturrock, West Palm Beach.

Mr. Harold Kendall, Goulds.

Mr. W. F. Ward, Avon Park.

An organization meeting of this committee has not yet been held for the purpose of electing officers and establishing policies. Such a meeting is called to be held here at the end of this program.

During the year your Chairman has served as Acting-Chairman of the Committee and with the help of individual members of the Committee has passed upon and completed preliminary registration of six new varieties. Four of these are new mango seedlings and the other two are new avocado seedlings. Apparently the idea of registering varieties of other fruits has not caught on as yet.

Description of the new varieties follows:

## NO. 1 STROTHMAN MANGO

*Origin*—A seedling of unknown parentage growing on the property of C. H.

Strothman, 519 S. W. 11th Avenue, Miami, Florida. The tree is large and spreading with rather dense foliage and is about 29 years of age. It has not been propagated commercially.

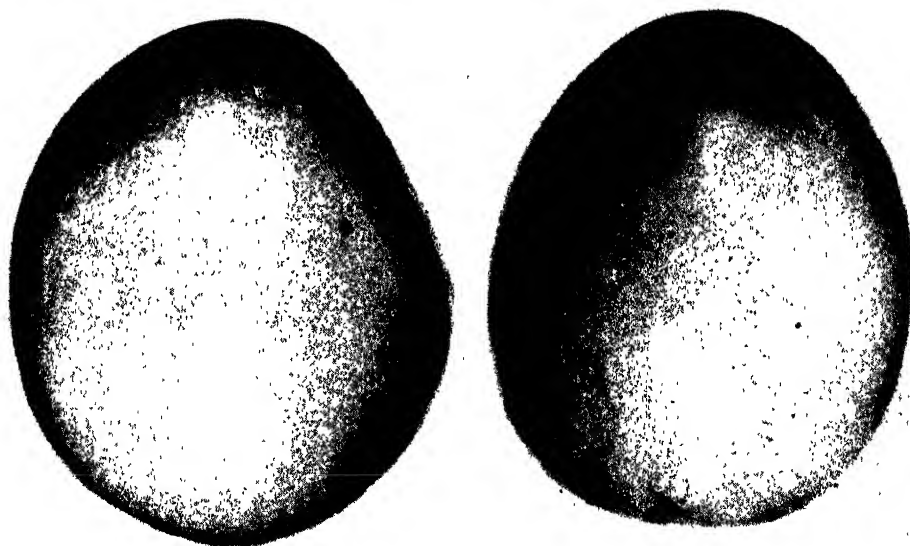
*Description of fruit*—Form oblong to oblong-ovate, plump (Fig. 1); size medium to large; weight 15 to 19 ounces (425 to 535 g.); length 4 1/2 to 5 inches (11.5 to 12.8 cm.); width 3 1/4 to 3 5/8 inches (8.6 to 9.2 cm.); thickness 3 1/8 to 3 1/4 inches (8.0 to 8.3 cm.); base rounded to obtusely tapering, the stout stem inserted a little obliquely level or on a slightly raised button; ventral shoulder rising and full the dorsal shoulder falling steeply; apex broadly rounded, beak none or small, the stalk inconspicuous, from 1/2 to 3/4 inch (1.5 to 2.0 cm.) from the apex on the ventral side; surface smooth, ground color greenish yellow, blushed light crimson on the exposed side, with numerous small yellow dots; skin thick, tough, separating fairly readily from the flesh; flesh deep yellow, medium firm, melting, juicy, with considerable fine, soft, short fiber close to stone; flavor mild, sweet, slightly aromatic, quality fair to good; stone making up 8 to 9 percent of the total weight of the fruit, with considerable short, fine fiber both sides; seed monoembryonic, filling about 3/4 of the husk; season June and July.

The original Strothman tree is a heavy and consistent bearer with fruit of desirable size and color, but somewhat lacking in quality.

## NO. 2 LIPPENS MANGO

*Origin*—A seedling of Haden, planted on the property of Peter Lippens at 135 N. W. 26th Street, Miami, Florida. The seed was planted in 1931 and the seedling first bore a crop in 1938. It has been propagated commercially since 1945.

*Tree and foliage*—The original tree has



Top—Fig. 1 Strothman Mango. Bottom—Fig. 2 Lippens Mango

a spreading form with rather dense foliage and is vigorous of growth. Mature leaves are grass green in color and of medium size.

*Description of fruit*—Form ovate oblong, and rather plump (Fig. 2); size medium, 12 1/2 to 16 ounces (350 to 445 g.), length 3 1/2 to 4 1/4 inches (8.2 to 8.8 cm.), thickness 3 to 3 1/4 inches (7.6 to 8.2 cm.), base rounded to slightly flattened, the fairly stout stem inserted a little obliquely in a slight depression; ventral shoulder full, rising very slightly above the base, dorsal shoulder sloping away gradually; apex rounded, beak none, the nak inconspicuous, level, 1/2 to 3/4 inch (1.2 to 2.0 cm.) from the apex; surface smooth, ground color deep yellow, blushed light crimson up to more than half the surface with a slight lavender bloom and numerous small yellow dots; skin rather thick and tough, not separating readily from the flesh; flesh deep yellow, medium firm, melting, juicy, with practically no fiber; flavor rich, sweet, moderately aromatic, quality very good to excellent; stone thin, oblong, making up 8 to 9 percent of the total weight of the fruit, with considerable short, very fine fiber which is not objectionable; seed monoembryonic, nearly completely filling the husk; season June and July.

The original tree is reported by the owner to have borne regularly and heavily since 1938. In some years it has borne very heavy crops with several fruits to a panicle. When visited in 1947, the fruit showed only moderate susceptibility to anthracnose and little tendency to seedlessness. Provided trees propagated from the parent bear as well, the Lippens should prove to be an excellent variety for commercial planting.

#### NO. 3 FLORIGON MANGO

*Origin*—A seedling on the property of John G. Kaiser, 802 N. E. 2nd Street, Fort Lauderdale, Florida. The seed was planted in 1932 and the tree bore fruit first in 1938, according to the owner. It has not been propagated commercially.

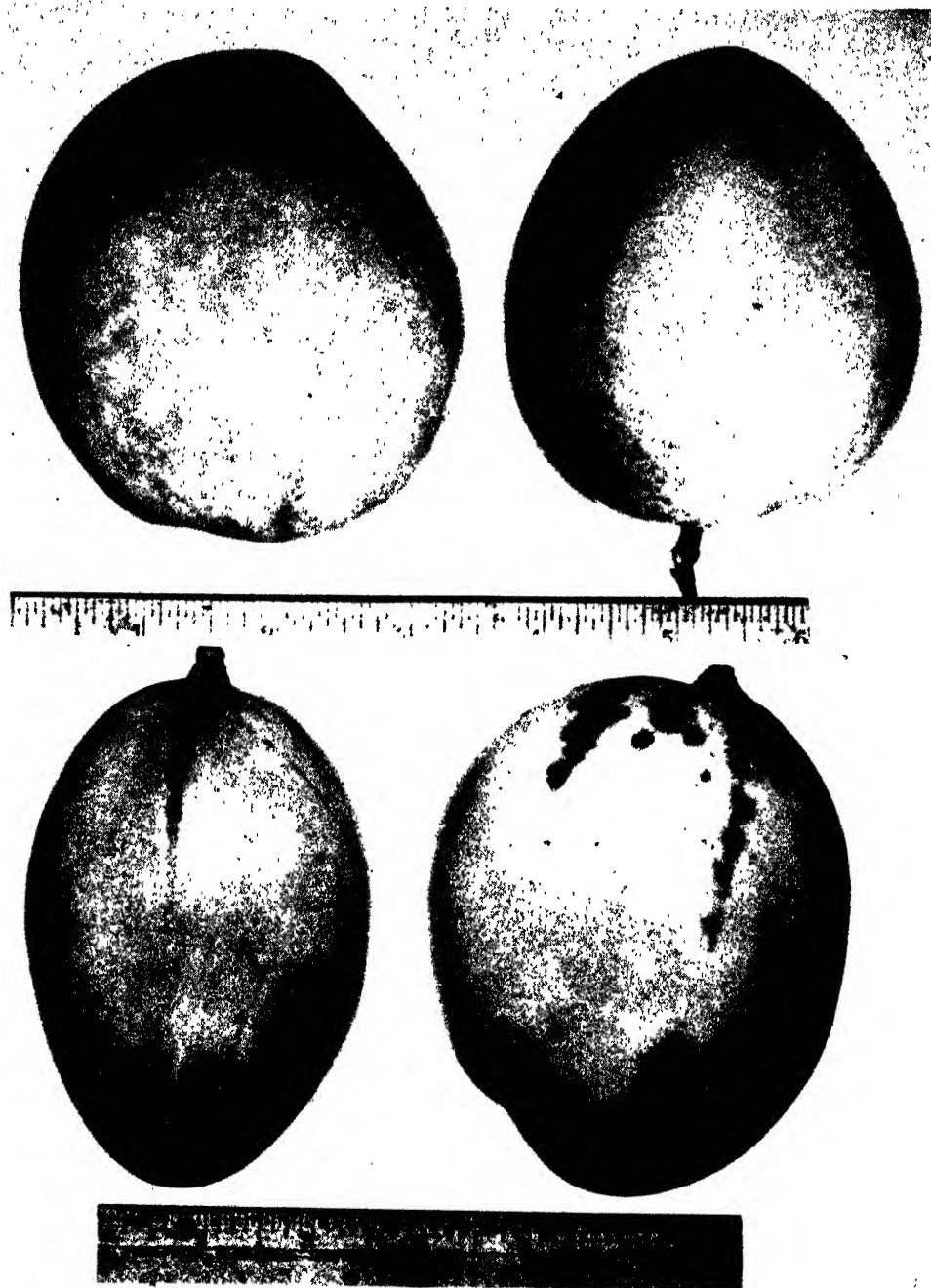
*Tree and foliage*—The tree is upright in form with rather thin foliage and is medium in vigor. Mature leaves are medium to large and grass green in color.

*Description of the fruit*—Form ovate, plump (Fig. 3), size small to medium, weight 9 1/2 to 15 ounces (267 to 427 g.), length 3 1/2 to 5 inches (8.8 to 10.0 cm.), width 3 to 3 1/2 inches (7.5 to 8.8 cm.), thickness 2 3/4 to 3 1/8 inches (7.0 to 8.0 cm.); base slightly flattened, the slender stem inserted squarely in a narrow shallow cavity; ventral shoulder full and rising slightly higher than the base dorsal shoulder sloping gradually; apex rounded to very bluntly pointed, beak lacking or very small and indistinct, nak inconspicuous, level, about 3/8 inch (1 cm.) from the apex; surface smooth, ground color greenish yellow to deep yellow, sometimes very faintly blushed on exposed side, with slight grayish bloom and numerous small yellow dots; skin medium thick and rather tough, not separating readily from the flesh; flesh deep yellow, medium firm, melting, juicy with no fiber, flavor rich, sweet, slightly aromatic, quality very good to excellent; stone making up 10 to 12 percent of the total weight of the fruit, with a fringe of short to medium fiber along the ventral edge; seeds mostly polyembryonic, filling the husk; season May 15 to July 30.

The original tree has been a regular and heavy bearer, according to the owner. Fruit that has been shipped is reported to have carried well. The seedling is superior to Cambodiana, and appears to be the most promising of the Saigon type mangoes observed thus far.

#### NO. 4. KEITT MANGO

*Origin*—A seedling of Mulgoba growing on the property of Mrs. J. N. Keitt 115 S. W. 2d Street, Homestead, Florida. The seed was planted in 1939 and, probably because the tree has received little fertilizer, is medium in vigor and of rather sparse, upright growth. It has not been propagated commercially.



Top—Fig. 3. Florigon Mango. Bottom—Fig. 4. Keitt Mango

*Description of fruit*—Form oval (Fig. 4); size medium to large; weight 17 to 24 ounces (475 to 675 g.); length  $4\frac{1}{2}$  to  $4\frac{3}{4}$  inches (11.00 to 12.2 cm.); width  $3\frac{1}{2}$  to  $4\frac{1}{8}$  inches (9.0 to 10.5 cm.); thickness  $3\frac{1}{4}$  to  $3\frac{1}{2}$  inches (8.3 to 8.9 cm.); bases rounded, the stout stem inserted slightly obliquely either level or on a very slightly raised button; ventral shoulder full and rounded, the dorsal shoulder falling steeply, apex rounded to bluntly pointed, beak none, the nak inconspicuous about  $1\frac{1}{4}$  inches (3.0 to 3.2 cm.) from the apex on the ventral side; surface smooth; ground color bright yellow, blushed light pink on the exposed side with numerous small, pale yellow to russeted dots and rather heavy lavender bloom; skin thick, fairly tough, not separating easily from the flesh; flesh deep yellow, fairly firm, but tender, melting and juicy, with considerable fibers of medium length near the base of the seed but fine and not objectionable; quality good to very good; stone making up 7 to 8.5 percent of the total weight of the fruit; seed (of the specimens examined) monyembryonic, filling about half of the husk; season September.

The Keitt bore a good crop in 1945 and again in 1947. The hurricane in 1945 may have been responsible for its failure to bear well in 1946. This appears to be a promising seedling.

#### NO. 5. HAINZ AVOCADO

The Hainz originated as a seedling of unknown parentage on the property of Mr. Ed. L. Hainz at 33 West Center Avenue, Sebring, Florida. The tree is rather spreading in type, resembling a Waldin in habit, and is probably of West Indian parentage. It bore heavy crops in 1945 and 1947, thus showing a tendency to bear in alternate years. The fruit is medium in size, the specimens examined ranging from 8  $\frac{1}{4}$  to 14.5 ounces (232 to 415 g.) is pyriform, with a light green, slightly pebbled skin (Fig. 5). The seed is medium to large in size, making up about 15 percent of the

total weight of the fruit and is tight with a loose seed coat. The flesh is light yellow to greenish yellow next to the skin. Quality is only fair to good. The season of ripening is July and August. Flowering behavior and oil content have not been determined.

#### NO. 6. ELLIOTT AVOCADO

The Elliott originated as a seedling of unknown parentage on the property of the late David B. Elliott, 1021 West Lakewood Road, West Palm Beach, Florida. The age of the parent tree is not known but it attained a height and spread of approximately 40 feet. The foliage and fruit is of West Indian type. Yields are reported to vary from a few fruit in some years up to 100 in better years. The fruit is pyriform in shape and very large ranging from 28 to 42 ounces in specimens examined and it has a rather large loose seed (Fig. 6). The skin is thin and light green in color. The flesh is rich yellow, smooth and of good quality. The oil content of the fruit and the flowering behavior have not been determined. This variety is not desirable as a commercial avocado, but shows some promise as a good sort for home planting, where a very large fruit of good quality is desired.

The Kalusa variety registered in 1946 has continued to show promise. A good crop was produced this past year on the parent tree which was not damaged by the freeze of February 6, 1947. The owner of the original tree has propagated and planted a block of young trees during the year.

The Herman variety, which has been propagated and planted on a small scale in Dade County in recent years, proved susceptible to cold in the freeze of February 6, 1947. Trees 1 to 3 years of age froze back as severely as Pollocks of the same age in several groves, and trees of bearing age proved no hardier than Waldin and Pollock.

The Hall variety, on the other hand, proved to be quite hardy, comparing favorably with Lula and Taylor in this respect.

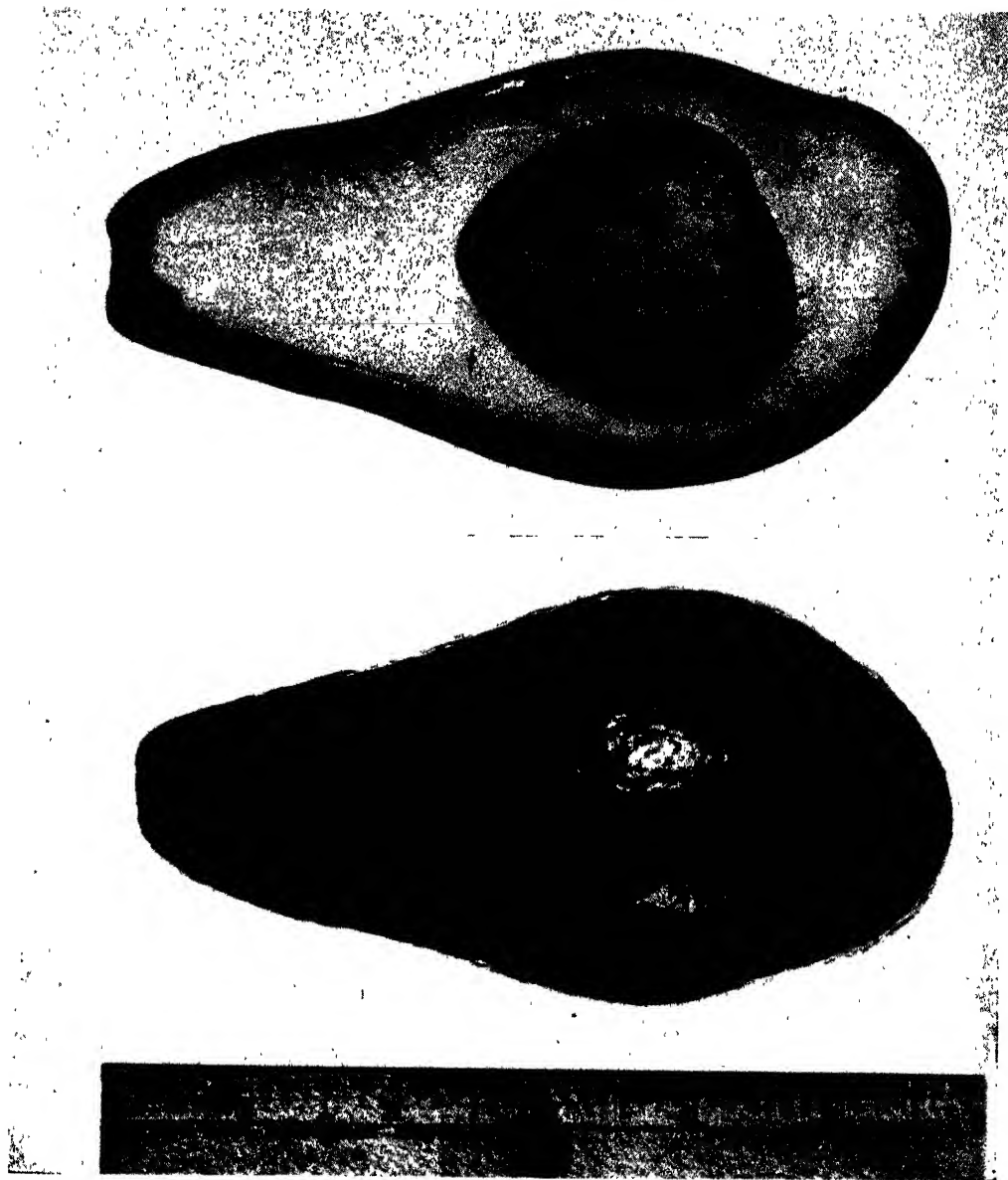


Fig. 5. Hainz Avocado

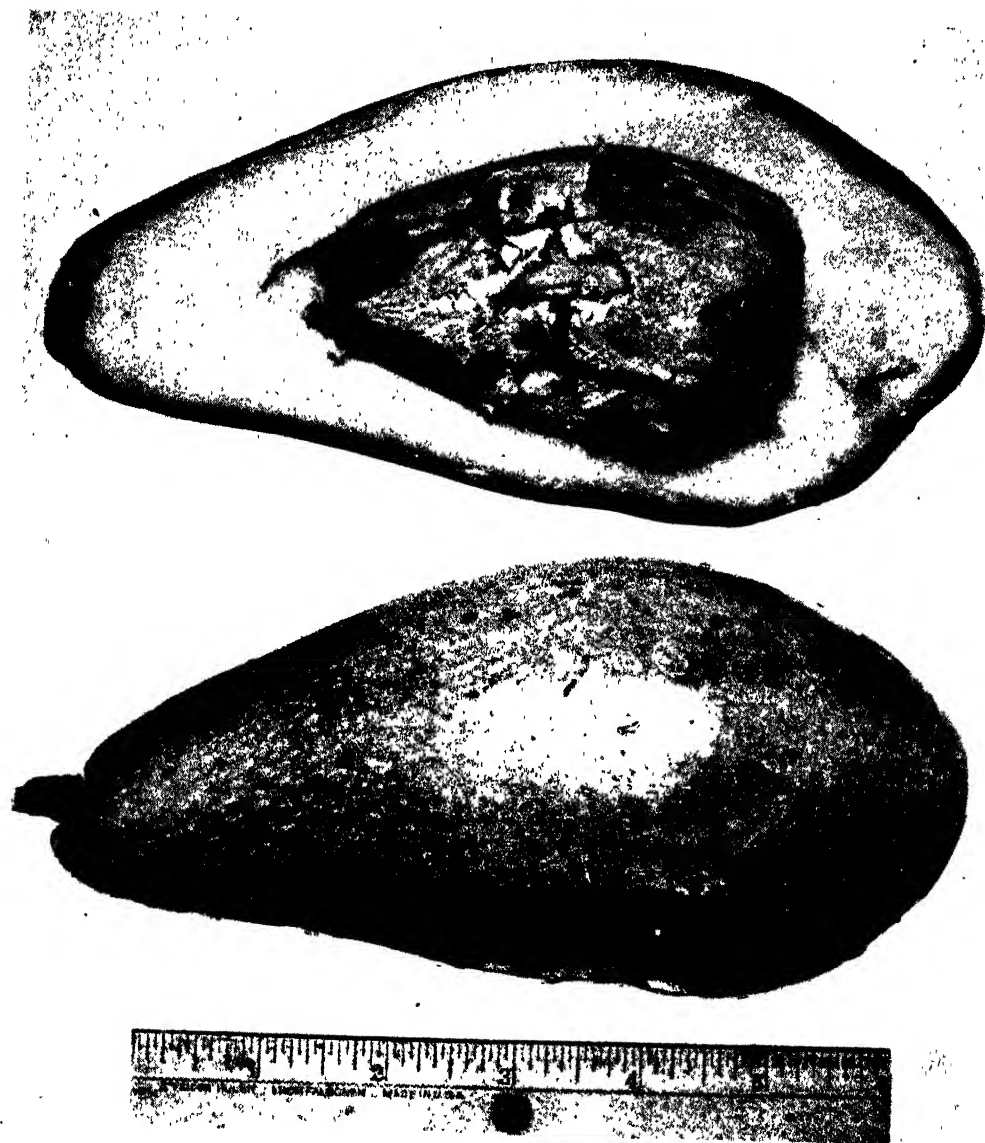


Fig. 6. Elliott Avocado

# ORNAMENTAL SECTION





# PROBLEMS IN GLADIOLUS PRODUCTION

ROBERT O. MAGIE, *Pathologist, Gladiolus Investigations, Vegetable Crops Laboratory Florida Agricultural Experimental Stations*

Bradenton, Florida

In 20 years gladiolus production in Florida has grown from a few acres into a major industry. It is estimated that over 5000 acres will be planted to gladiolus this season. The major part of this acreage yields its flower harvest at a time when flower production elsewhere in the nation is practically limited to the greenhouse. Enough gladiolus cut-flowers go to market from this State to supply each person in the country with about one flower spike per year. This production of over ten million dozen spikes produces more wealth than any one of the State's vegetable crops, with the exception of tomato, beans, and celery.

The rapid growth of our gladiolus industry since the end of World War II brings up visions of the occasional glutted markets of pre-war days. Unless present efforts to advertise effectively, to expand existing markets, to develop new markets, and to improve the quality of the product are extended and backed up by all growers, this threat of over-production is real.

It is believed that Florida's gladiolus production may be expanded many times before the potential market for this flower is satisfied. The greater part of our flowers sold in the past have gone into the florists' design and funeral pieces. The gladiolus growers, by marketing pre-packaged flowers for the homemaker through the chain stores, are taking an important step forward in expanding the cut-flower market. It is not hard to imagine that many homemakers would be eager to buy attractive flowers at a reasonable price.

With the recent coming of rapid transport

in the form of refrigerated trucks and air freight, the growers are putting a fresher product on the market, often directly into the hands of the retailers rather than through centralized distributors, for which they receive a premium price. Rapid transport is extending the market area. Also, air freight makes it possible to put 2 or 3 extra days' flower cut on the distant markets for any one holiday.

Gladiolus production is reduced in volume and in quality by diseases, insects and by mal-practices. It is the purpose of our research on gladiolus to increase the quantity and quality of production and thereby lower the cost of production and the sale price of cut-flowers. A modest reduction in the consumers' price should result in a disproportionately larger market.

The production problems in this industry are many and varied. Only the critically important problems can receive attention at present. The control of certain diseases which have increased in severity in recent years is receiving major attention, since the diseases are the biggest factor in reducing the quantity and quality of the cut-flowers produced on the average acre.

The Fusarium corn rot and yellows disease is not as destructive as it was a few years ago when half of the Picardy corns were lost in 2 or 3 seasons. Practically all susceptible varieties are now treated, before planting, in a one-quarter percent solution of New Improved Ceresan. The annual loss from the Fusarium disease is now estimated to average 7 percent of the variety Picardy and its sports. These and other susceptible varieties comprise over 80 percent of the total production. Much work has been done and is being done to develop other control measures to reduce this expensive loss.

The leaf spot disease has taken an annual

toll for several years. The disease may kill the foliage before flowering, or more usually after flowering. Most of the important commercial varieties are very susceptible to the leaf spot. The disease becomes epidemic during the winter and spring months, disappearing during the summer. A fungus resembling a *Stemphylium* was isolated from the leaf spot at this laboratory early in 1944. The same type of fungus was again isolated early this year. Certain fungicides when applied as sprays each week were effective in reducing the leaf spot infections if the spray applications were begun at the first sign of infection. The most effective materials in our spray tests were Zerlate, Dithane and Parzate.

The most threatening and potentially serious disease at present is caused by a *Botrytis* fungus which attacks the leaves, florets and corns of most gladiolus varieties, if not all. There is an insidious phase of this disease in that the cut-flowers may appear healthy when packed and then become rapidly rotted in transit or in cool storage. The floret phase may appear when the disease is not readily detected in the field.

The corm rot phase is relatively new to Florida, being recognized for the first time on corns coming out of cold storage this fall. It may be that the prolonged cold wet period of last February was responsible for this flare-up of *Botrytis* corm rot. All affected stocks were in the field at that time and *Botrytis* infection became severe on the leaves in some fields during the month.

Diseased leaf and flower specimens, somewhat resembling the *Botrytis* infections, were received from most of the important production centers of Florida and Alabama this summer and fall. All of these specimens yielded a fungus which is apparently newly associated with gladiolus. The name of the fungus is *Curvularia lunata* (Wakker) Boedijn. Tests are underway to determine whether the disease is caused by this fungus or whether *Curvularia* is only a secondary fungus obscuring the casual agency.

The sudden increase in severity of the *Botrytis* disease last winter plus the appearance of an apparently new disease have given the growers cause for much alarm. In order to discover control measures against the *Botrytis* disease as quickly as possible, extra personnel and funds have been allocated to this emergency program. Test spray plots will be located in the important winter production areas of the State. Fungicidal treatments of corns and cut-flowers will be tested at the Bradenton Laboratory. The *Botrytis* disease will be studied to determine at what phase of its development it is most vulnerable to attack. It may be possible to discover a simple and inexpensive measure of control. The possibility of other plants acting as hosts of the fungus will be studied. A well-rounded control program will take years to develop.

There are many other types of problems on which research work has been initiated or planned for the future. An extensive variety testing program is under way. Along with this we are breeding new varieties among which we hope to find resistance to the major diseases. The purpose of testing these hundreds of varieties is to find better ones for Florida. We urgently need varieties which will resist the leaf spot and *Fusarium* diseases, as well as the *Botrytis*. The problem is to combine the resistance which we find in some varieties with the characters of Picardy which have made this variety the leading commercial for over 10 years. We propose to get these combinations of desirable Picardy characters with disease resistance by selfing existing varieties which are themselves the product of crosses between Picardy and Maid of Orleans, for instance. By inbreeding, the desired combinations of characters should show up.

Our idea of what the perfect gladiolus cut-flower variety should be will surely be changed by the use of air transport and the demands of the homemaker. No longer must our flowers undergo the terrific punishment of traveling without a drink in non-refrigerated cars for 3 or 4 days. Our commer-

cial varieties can take this punishment and give a good performance, but the premium price being paid for air-shipped glads indicates that they perform better when treated kindly. Many beautiful varieties which were not suited to commercial production because they did not ship well may prove to be good performers when shipped quickly by air. The homemaker will want the dainty, small decorative varieties as well as the large commercial varieties with which we are familiar. A well-grown spike of most commercial varieties is much too large for any vase the average home can supply. Also the smaller glads fit the average room of the home better than the large spikes. It is time that we begin to cater to this market.

Further investigation on the gladiolus

farm to see where the grower can cut down on costs of production will show us many operations that might be eliminated or reduced in cost by the use of labor-saving machinery, by using new weed-killing devices and chemicals, and, possibly, by handling the corms differently. The use of fertilizer is a matter about which much is said but little is known definitely from experimental evidence. The growers tend to blame the fertilizer when their plants look sick. There is a definite feeling with some growers that their fertilizer program is faulty.

These and other problems need investigation. Research can point out the best practices which will lower the costs of production, and equally important, improve the quality of our cut-flowers.

## DEFICIENCIES IN ORNAMENTALS

R. D. DICKEY

*Florida Agricultural Experiment Station  
Gainesville*

Ornamental plantings are made for a specific purpose to produce definitely desired effects. If the plants used in the landscape are well adapted to the environment in which they are placed and make a vigorous thrifty growth, they serve the purpose for which they were planted. If, for any reason, they fail to make a thrifty growth, their desirability for ornamental purposes may be materially reduced and thus they may ultimately prove a disappointment.

The mineral soils of Florida are generally deficient in the major plant foods—nitrogen, phosphorus and potassium—and usually require the addition of these materials for normal healthy growth. Organic soils are high in nitrogen but may be deficient in phosphorus and potassium.

### MICRO-ELEMENT DEFICIENCIES

During the past 15 years much work has been done on the micro-element deficiencies of fruit, nut and vegetable plants in Florida and, to a similar but lesser degree, with certain ornamental plants. Under some conditions and in certain locations, even though nitrogen, phosphorus and potassium have been supplied in adequate amounts and other conditions are favorable for growth, some plants may still remain in an unhealthy condition.

Some of these malnutrition troubles are caused by a deficiency of certain of the micro-elements. Thus far, micro-element deficiencies due to manganese, zinc and iron are the only ones reported on ornamental plants in Florida.

### MANGANESE DEFICIENCY

A manganese deficiency of several ornamental plants has been identified in Florida (1, 2, 3). Though disorders due to this cause are common on the acid sands of the



Figure 1—Symptoms of manganese deficiency and effect of manganese sulfate spray.

- A. Treated and chlorotic leaves of *Sander bougainvillea*. Left, an affected leaf 5 weeks after treatment with manganese sulfate spray. Right, an untreated chlorotic leaf on same plant.
- B. Typical treated (a) and untreated (b) *Thunbergia grandiflora* foliage from same plant.
- C. Typical treated (right) and untreated (left) foliage of camphor tree.
- D. Typical chlorotic branch of *Agyneja impubes*.

central and southern peninsular areas, they are most prevalent and acute on the calcareous soils of the coastal areas.

Leaves on affected plants show chlorotic areas between the midrib and primary veins (Fig. 1). Usually, affected leaves are normal or nearly so but in chronic and acute cases they may show some reduction in size. In severe cases the foliage is sparse and some dead wood may show in the plant.

Woody ornamental plants that evidence a chlorosis due to a manganese deficiency are: Crape myrtle, bougainvillea, allamanda, cattley guava, flame vine, *Agyneja impubes* L., Bengal Clockvine, camphor tree, cape plumbago, crape jasmine, wax privet, glossy privet, furry or downy jasmine, rusty fig of Australia, pale butterflybush, *Psidium* sp. and sweet viburnum.

Spray and soil treatments are the 2 general methods of controlling chlorosis of plants produced by a manganese deficiency (Fig. 1). Spray applications are most effective when made during or just before a period of active growth, hence from spring to early summer is usually the best time to spray. As a general rule, response of chlorotic foliage will be observed from 2 to 8 weeks after treatment. Usually, 1 or 2 applications during the year will effect satisfactory control. However, under some conditions it may be necessary to make several spray treatments annually to maintain healthy growth. Care should be taken to cover all of the foliage with the spray as only those portions of the plant responded which had been sprayed.

A suitable spray mixture for ornamentals may be prepared by dissolving 2 ounces of manganese sulfate in 2 1/2 gallons of water, and then adding 1 ounce of hydrated lime. Dissolve the manganese sulfate by sprinkling it into the water while stirring with a paddle. Make the lime into a smooth paste by the addition of a small quantity of water and thoroughly mixing, then add slowly while the manganese solution is stirred rapidly. Add some good spreading agent to the spray at the rate suggested by the man-

ufacturer. Apply the spray immediately with any type of spraying equipment which will produce a good mist. The spray should not be allowed to come in contact with buildings, particularly stucco or brick, as it will stain them.

Soil treatment, when effective, is the most satisfactory method of control because of the residual effect and ease of application. Satisfactory response to soil applications of manganese sulfate have been obtained on several shrubs and vines growing in both acid and alkaline sands. Limited soil treatments with some shrubs and experience with other plants on the marl soils of the Miami-Homestead area indicate that soil applications of manganese sulfate will probably not be satisfactory on this type of soil. The amount of manganese sulfate to apply will range from 1/4 to 1 pound per plant, depending upon size and severity of symptoms. The initial soil application should be made during spring or early summer. The need for subsequent treatments will be determined by the condition of the plants. As a general rule, soil applications take longer than sprays to produce greening-up of the foliage. From 1 to 6 months or even more may be required for complete response. On alkaline soils it is desirable to mix an equal amount of sulfur with the manganese sulfate. A well rounded control program would be first to green up affected plants with a manganese spray. Then supplement spray with soil applications which will give a supply of manganese to the plant that will keep it in a healthy condition.

It is not possible to make definite recommendations at this time in regard to soil applications to ornamental trees. However, this method of control may be effective on acid sands if sufficient manganese is supplied. Limited trials with the camphor tree indicate that satisfactory control will be much more difficult to obtain on alkaline sands. In all probability, soil applications to trees will not control this disorder on marl soils.

A serious growth-retarding trouble of the queen palm (*Arecastrum romanzoffianum* Becc.) variously called "curly top," "curly leaf" and "frizzle leaf" is quite prevalent in Florida. A chlorosis of the leaves is the first symptom to appear on affected palms. In advanced stages the leaves are chlorotic, necrotic areas appear in the leaflets, the leaves are much reduced in size and the entire leaf presents the "frizzle leaf" appearance so characteristic of this disorder.

It has been found (2) that this trouble is a manganese deficiency and that it can be controlled by soil or spray applications of manganese sulfate. Both methods of application were equally effective. The time required to effect control was, in most instances, from 3 to 6 months. Soil applications of manganese sulfate were made broadcast under the spread of the top, by "plugging" and in a small cleared circle at the base of the tree. All 3 methods were equally effective. Soil treatments made in March, April, May and August were equally effective and 1 treatment per year was as good as 2 provided enough manganese sulfate was applied. The amount to be applied should range from 1/2 to 5 pounds per tree, depending upon tree size. Those palms which fail to respond properly, in from 3 to 6 months after treatment, should be re-treated. Soil applications were effective on acid and alkaline sands but it is yet to be determined whether soil applications will be effective on marl soils.

Similar results were obtained from spray applications and time required for response was approximately the same as with soil treatments. In spraying the palms the bud must be wet thoroughly. It is quite possible that it is not necessary to spray the entire palm but only to pour the spray into the bud making certain that it is thoroughly drenched. The manganese sulfate spray previously discussed is satisfactory for this purpose.

A chlorosis of the Canary Island date palm (*Phoenix canariensis* Chaub.), caused by a manganese deficiency, has been ob-

served at several locations on the east and west coasts. Applications of from 1 to 4 pounds of manganese sulfate per tree on small to medium palms, depending upon tree size, produced a marked response in 3 months. Spray treatments were not tried but they should be equally effective.

#### ZINC DEFICIENCY

Zinc deficiency of ornamental plants is not nearly so prevalent as manganese deficiency but has been identified on several plants on the marl soils of the extreme southern area (5, 6).

Leaves on affected plants are chlorotic and in acute cases much reduced in size, producing a "little-leaf" condition characteristic of zinc deficiency. When symptoms are severe, twigs may be partially or entirely defoliated and many of these later die-back.

Plants evidencing symptoms of this disorder, which responded to a zinc sulfate spray, were: orange-jessamine (*Murraya exotica* L.), wax privet, loquat, silk oak (*Grevillea robusta* Cunn.), Hatai catalpha (*Catalpha longissima* Sims) and American elm. This trouble is apparently more prevalent on orange-jessamine, a citrus relative, than the other plants mentioned. Zinc deficiency has been observed at several locations on the west coast as well as on the marl soils of the Miami-Homestead area.

Zinc deficiency can be controlled by using a zinc sulfate spray. This spray is made in the same manner as described for the manganese sulfate spray by using 2 1/2 gallons of water, 2 ounces of zinc sulfate, 1 ounce of hydrated lime plus a good spreader. Soil applications of zinc sulfate have not been tried experimentally, but the results obtained with citrus indicate that soil treatments would probably not be effective in the central and southern portions of the state.

#### IRON DEFICIENCY

Iron deficiency has been reported on only 3 woody ornamental plants in Florida,

namely: Azalea, gardenia and *Bignonia magnifica* Bull. (4, 7). This disorder is much more prevalent and acute under alkaline soil conditions but may sometimes appear on acid soils.

Symptoms of iron deficiency are a pronounced chlorosis of the foliage in which the leaves are yellow with the veins appearing as fine green lines. Young forming leaves are dwarfed, growth of the plant is reduced or many cease altogether, some of the affected leaves fall and dead wood appears in the plant.

Azaleas and gardenias have long been known as acid-loving plants because, under alkaline soil conditions, they frequently develop a so-called "lime induced chlorosis."

This trouble is an iron deficiency brought about by the calcareous soil rendering the iron unavailable to the plant. However, iron deficiency may sometimes develop on these plants under acid soil conditions.

This trouble can usually be remedied on azaleas by spraying with a 1 or 2 percent iron sulfate spray. This spray is made in the same manner as previously described for manganese sulfate spray, using 2 gallons of water, 2 1/2 to 5 ounces of iron sulfate, an equal amount of hydrated lime and a suitable spreader. In addition to the spray, measures should be taken to acidify the soil. For quick results aluminum sulfate should be used, but agricultural sulfur will correct the trouble in a reasonable time. Either is applied at the rate of 2 to 3 pounds per 100

square feet. These, in conjunction with soil applications of iron sulfate, will control the trouble. Mulching the plants with acid peat, compost, leafmold or other decaying organic matter will be helpful. If the soil is not naturally well supplied with organic matter, then considerable quantities should be mixed with the soil before planting.

Iron deficiency of gardenias cannot be controlled by spray applications of iron. However, soil treatments as described for azaleas, will correct the trouble on gardenias.

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# DISEASES OF ORNAMENTALS

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Mr. Chairman, Ladies and Gentlemen:

The subject of this talk, diseases of ornamentals, is a term frequently used in conversations and discussions, spoken glibly as though it were a simple matter, clear-cut and uncomplicated. Actually nothing could be farther from the truth. I would like to give you some idea of its complexity, its importance and what has been done and is being done towards its solution.

The value of ornamental plants in Florida is enormous. I have no conception of what it amounts to in dollars and cents but I am sure it runs into tens of millions. You have heard previous speakers hint at the size of the gladiolus and easter lily industries in the State. Those are only two of many crops classed as ornamentals. Gladiolus is the leading cut flower grown in Florida, but there are many others. For instance Asparagus "fern" alone is cut annually from a large acreage.

The florists of Florida grow thousands of acres of flowering plants for their local trade. Not only is the winter business in this line important but there is now enough summer demand to make it an all-year proposition. Another branch of this sort of horticulture is the growing of plants to be shipped to northern markets as potted plants. A commercial enterprise of long standing is the nursery business. Although the investment of nurserymen in azaleas and camellias alone is tremendous these two plants constitute but a small part of the varied stock that must be grown and carried for landscaping in Florida.

So far we have been talking about com-

mercial plantings. Private and semi-private installations are almost as important. City parks are frequently landscaped with exotic ornamentals, sometimes with rare plants as in the Bay Front Park in Miami. Such developments as Cypress Gardens and Ravine Gardens employ ornamental plants by the acre. Hotel plantings are frequently extensive and some of the better tourist-cabin grounds are now being landscaped extensively. However it is round private homes where the greatest number of ornamental plants are used. There are literally thousands of miles of Florida streets lined with homes, each landscaped to the owner's taste with shrubbery or flowering plants. The total value of all these plantings is enormous.

All plants are subject to disease and on ornamental plants, disfiguring diseases are especially deleterious. Since many diseases are confined to one or a few species of plants, the number of diseases to be dealt with in any area is directly proportional to the number of species present. Florida's climate and geographical location are so beneficent that over 3500 species of plants grow here naturally. These same factors favor the growth of a much larger number of exotic or introduced species, most of which are ornamental plants. In addition, certain agencies of the United States Department of Agriculture and some private individuals are continually bringing in and distributing new species. As the number of species grown here becomes greater, the disease problem becomes larger and more complicated. This is certainly true when a new species is grown in larger numbers, especially when concentrated in one or a few localities.

Diseases vary too, depending on the class of plant that is attacked. Trees and shrubs are likely to be susceptible to diseases very

different from those attacking herbaceous perennials. Therefore the nurseryman will have to deal with diseases different from those combatted by the florist. The plantsman growing annuals has still a different set on his plants. Bulb growers can expect quite different fungi to attack their crop. Here in Florida many tender foliage plants are grown under shade and play host to still another array of parasitic organisms.

The disease may be classified still further according to the parts of the plants attacked. To begin with there are the so-called damping-off diseases that attack seedlings and very young plants for the most part. They vary greatly in nature and control from the root rots of woody plants such as shrubs and trees. Those fungi which attack stems constitute another category altogether different. Leaf-spotting diseases are almost as numerous as the kinds of plants. Occasionally fungi attack blossoms and we have a very serious condition as with the azalea flower spot disease. We can add to these the mildews, powdery and downy, the rusts and all the virous diseases such as mosaic, rosette, etc. These are only the diseases caused by parasites. We have as well the physiogenic troubles due to the action of toxic chemicals, deficiencies of certain elements and the water-induced abnormalities.

Truly we have a complicated problem under discussion, one that reveals few of its ramifications in that common expression "diseases of ornamentals."

You may well ask what is being done about it. Dr. Magie has outlined some of the work that is going on at the Bradenton Station, work dealing with only some of the phases of the gladiolus disease problem. He was preceded by other pathologists in the same field. Camellia diseases are under investigation at the Main Station in Gainesville. Money is available for another man to work on diseases of ornamentals at Gainesville but so far no capable pathologist has been found to take the position.

Many of the diseases of our Florida plants have been studied elsewhere and control measures worked out. In some cases these can be adapted to Florida conditions, for instance, when the work was carried on in another Southern State. On many other diseases there is no published information in this or any other country. Moreover many of the newer fungicides may be more effective in certain cases than the old established bordeaux and similar sprays, but we don't know. With the organic fungicides, each individual case must be worked out. The job of learning how best or even how to control the diseases of ornamental plants in Florida is a large and important one. It will not be completed this year nor next.

## "BULBOUS PLANTS ADAPTED TO FLORIDA"

By WYNDHAM HAYWARD  
Winter Park

The growing of bulbs, tubers, tuberous-rooted and rhizomatous plants in Florida is one of the more or less neglected phases of ornamental horticulture in our wonderful "Sunshine State," and in the very beginning of my remarks I would like to say that I believe we are fifty years behind the times in that phase. To the regret of all sincere

flower lovers and plantmen, the recent World War II has given it another serious setback.

The number of bulbs, tubers, cormous plants, etc., which may be grown successfully in Florida is legion, but only a few of these have come to the front as important commercial items, as gladiolus, the calla lilies, Polyanthus Narcissus, hybrid Amaryllis, Fancy Leaved Caladiums, Easter Lilies, Hemerocallis, Gloriosas, and a few others.

The growing of bulbs in private and public gardens is on a greatly restricted scale. Certain bulbs, as the Dutch Iris, an important winter florists' flower, both in the North and South, are grown commercially in Florida to some extent from imported bulbs, these coming either from the Pacific Northwest or Holland.

Bulbs have a long and honorable history in Florida, mostly unwritten, and much of it lost to horticultural annals. The widespread occurrence of various exotic *Crinum*s in the city and country over the state, especially in old gardens, plantations and estates, indicates an appreciation of these giants of the bulb family which must date back centuries, probably to early Spanish times. The large numbers of such species as *Crinum Asiaticum*, *Crinum Amabile*, *Crinum Zeylanicum* and other "milk and wine" types of the genus, which are largely natives of Southeast Asia, the East Indies and the Pacific Islands, tends to show a horticultural connection with the Far East which must have been established many years ago, certainly in sailing ship times. It is entirely possible, of course, that these bulbs came to Florida as a secondary stage in their introduction into the Western Hemisphere, possibly from gardens in the Philippines, West Indies (Spanish and British islands) and from Mexico and other parts of Latin America.

Of bulbs commonly growing in Florida today, I would consider the *Crinum*s as having the longest apparent pedigree as residents of our state. Next, perhaps were certain *Amaryllid*s, introduced from the West Indies and Latin America, as the *Amaryllis* species, *Zephyranthes*, *Hymenocallis*, the lovely Japanese *Lycoris radiata* or "red spider lily," and the equally lovely and rare *Lycoris aurea*. *Lycoris radiata* masqueraded as *Nerine Sarniensis* for many decades in North and West Florida gardens. Also the Easter Lily, which came in years ago from Japan doubtless by way of Bermuda, and certain tazetta types of *Narcissus* and jonquils, still found growing in a nat-

uralized condition on old plantations in North and West Florida.

There are bulb mysteries in Florida gardens. The *Lycoris aurea*, or Golden Hurricane Lily, found sparsely in old gardens around St. Augustine, is an utterly charming thing and one of the world's most beautiful flowers. There have been explanations offered for its presence there, but it seems likely that the story goes back to Spanish times. Some 12 or 15 years ago a planting of several hundred *Haemanthus multiflorus*, or East African Blood Lily, was discovered at Eustis, in negro yards. These must have multiplied over a period of more than 50 years or so. *H. multiflorus* is one of horticulture's most showy and spectacular bulb flowers. It is at home in Florida, and occasionally found as a pot plant over the state. It is considered too choice ordinarily to grow in the ground. The bulbs are worth five dollars apiece at this time. The explanation supplied by the original negro owners was that "grandma got a bulb off a sailor in St. Augustine" many years before. That is an excellent and plausible explanation.

There is a new species of white *Zephyranthes* which Dr. H. Harold Hume, noted Florida horticulturist and a leading bulb expert, found in a garden at Key West a few years ago. It has since been located in gardens on the West Coast near St. Petersburg. He has named it *Z. insularum*, and it is a real addition to our Florida bulb gardens, a lovely white-flowered spring-blooming species, of easy culture. It fills a need with the *Zephyranthes* collectors.

These examples show the romance which may be found in searching over old gardens and country places in Florida for such bulb finds. There are others still awaiting the searcher, without doubt. In the cities, the front porches and backyards of negro homes in the older sections will reveal many surprises in bulbs and other rare plants.

The modern phase of bulb growing in Florida may be said to date from the arrival

of the late Dr. Henry Nehrling in Orange county back in the 80's. At that time the late Theodore L. Mead was settling in Lake county and later at Oviedo, now in Seminole county, a few miles southeast of Sanford. Dr. Nehrling brought with him an intense horticultural interest in *Amaryllis* and many other bulbs and tubers among other things. His enthusiasm may well have induced Mr. Mead to take up various bulb cultures, in which they both figure largely in the horticultural history of the state.

In his little monograph "Die *Amaryllis*," published in Germany in 1909, and which regrettably has never appeared in English translation up to this time, Dr. Nehrling told of seeing various *Amaryllis* species and hybrids in numerous gardens on his way South from Jacksonville to Orlando on his first trip to Central Florida in 1886. He moved to Florida a few years later permanently, and undertook serious experiments and the commercial growing of *Amaryllis*, Fancy-Leaved *Caladiums* and other bulbs and tubers at his Gotha gardens. According to his own writings, he imported the choicest stock available from Europe and elsewhere to aid him in his hybridizing experiments.

A single bulb of the Nehrling *Amaryllis*, which Dr. Nehrling gave him at Gotha on a visit, was T. L. Mead's start in the growing of the hybrid *Amaryllis*, according to Mr. Mead's own story to me more than 15 years ago. His commercial planting of the bulbs was disseminated widely over Florida and the lower South so that the Mead strain is now the principal trade strain of these gorgeous bulbs in America. Mr. Mead said that when that one bulb came into bloom, he wrote to Dr. Nehrling at Gotha (in those days the two communities were a day's travel apart) and asked him for pollen of other good *Amaryllis* flowers to use on his plant. Dr. Nehrling sent the pollen, and Mr. Mead raised some 180 seedling bulbs from the result. That was the start of the Mead strain, now a rather meaningless word, as little effort has been taken in

recent years to maintain a high standard quality of flowers in commercial plantings.

There are a number of native bulbs, tubers, etc., in Florida, interesting for ornamental use in the garden, but few of commercial value. Among those we can mention various *Hymenocallis*, *Canna flaccida*, *Crinum Americanum*, and the *Zephyranthes* species, *Z. Atamasco*, found in North and West Florida, *Z. Treatiae*, native of Central and Northeast Florida, and *Z. Simpsoni*, a distinct species found in lower Florida. These are all white in color, fading to pinkish. They are natives of low, flatwoods or rather swampy locations, and occasionally are seen in bloom in large numbers along roadsides after spring fires have swept the fields.

They can be grown in pots with care, or in beds of sandy loam soil in a lath house with good results. With the writer they have bloomed for a decade in high hammock soil under lath shade. Types of the *Z. Atamasco* from around Tallahassee are among the largest flowered of the entire genus, with blooms up to four inches across. These *Zephyranthes* bloom in early spring. They are tiny bulbs an inch or so in diameter at best, with slender green or glaucous linear leaves, and bearing their small flowers on 6 to 12 inch stems. There are dozens of other species of *Zephyranthes* and closely related small-flowering *Amaryllids* in Texas, the West Indies and all through Latin America, including *Cooperia*, *Habranthus*, etc. Most of these are to be recommended for Florida bulb gardens, with the exception of the Texas *Zephyranthes* species, and they are possible with extra care.

Especially recommended are *Z. grandiflora*, the common large pink Rain Lily or Fairy Lily of front porches and gardens, *Z. rosea*, a tiny rose-pink jewel, *Z. insularum*, spring-blooming white, *Z. citrina*, the best yellow, *Z. Ajax*, a straw-colored hybrid, *Z. candidum*, late white, and *Habranthus robustus*, beautiful lavender and white from Argentina, formerly considered a *Zephyranthes*. The *Cooperias*, — Drum-

mondii, pedunculata, Smalli and Traubi, all are worth trying in Florida. These miniature bulbs take the place in Florida of the Crocus and similar small bulbous items in Northern Gardens. They will reward the grower with a maximum of delicate and dainty beauty for a modicum of care and attention. I grow them in flats, for the most part, using a sandy loam soil with one-fifth part well rotted cow manure, and providing good drainage. They like part shade.

Under Dr. Nehrling's and Mr. Mead's efforts, Florida became the great source of Fancy Leaved Caladiums for the nation's florists trade in the early decades of the 20th century. Their work began half a century ago. Fancy leaved caladiums are not a new bulb, but were exhibited at the Philadelphia Centennial Exposition in 1876 and at the World's Fair in Chicago in 1892. The Mead and Nehrling varieties have dominated the trade for many years. Other hybridizers in Brazil and Europe have produced a large number of varieties, and some work is still going on with this bulb in breeding at this time, but the two pioneer Florida breeders left comparatively little for their successors to do. Of course, Nehrling and Mead used parent stock of the best kinds then available. Foreign-originated varieties have not stood the test of time so well in the American trade. Only this season I received a price list of Fancy Leaved Caladium varieties from a firm in India offering, among others, a number of the Nehrling and Mead varieties.

Unfortunately the trade nomenclature of fancy leaved caladiums is badly confused, a number of varieties being offered under several names and various other kinds having been given new names by ignorant or unscrupulous growers, so that the situation is hopeless and aggravating except in the case of a few kinds.

Fancy Leaved Caladiums, like the gladiolus, calla lillies, hybrid Amaryllis, Polyanthus Narcissus and Easter Lilies, are among the few bulbs and tubers now grown

commercially on an acreage basis in Florida. They are popular pot and tub plants and widely used for bedding over the state, and the Lower South generally. They are growing steadily in popular demand in the florists trade in the North, where thousands of the tubers are sold and forced annually for colorful foliage plants. There is now a trade for the shipment of started bulbs in small pots from Florida.

The caladium requires a rich, peaty or mucky soil, or heavily manured location on higher land, to be at its best, with abundant water. On rich land, the bed should be well drained but moist. The root knot nematode is the worst enemy in sandy soils. It is possible that the new soil fumigants and nematocides will make it possible to grow the tubers under ordinary lath house conditions with greater success and facility. In commercial plantings on rich soil, they are usually grown in the open air.

The gladiolus is too well known over Florida to require more than the statement that it is one of our most dependable and useful cormous plants for the home garden and commercial growers of cut flowers. It is cultivated by the hundreds of acres for shipping north and local sales. Regretfully it may be said that there has been a serious lack of worthy effort in breeding of new varieties adapted to Florida conditions, especially suited to this climate, and originated in the state, but this matter is receiving some attention at this time from the state experiment station authorities, I understand. There is also little effort to grow the bulbs for sale as bulbs. Possibly the costs are excessive in Florida for this kind of culture on a large scale, as the best bulbs are grown without cutting the blooms for sale.

Florida needs, urgently, a state experiment station project on the growing of commercial bulbs, beyond what is now being done in the field of Gladiolus and the inspection of various crops like Gladiolus, Narcissus, hybrid Amaryllis, Easter Lilies, etc. We need further competent experimentation

in the breeding and culture of choice commercial types of hybrid *Amaryllis*, *Narcissus*, *Calla* lilies, *Easter Lilies*, etc. In most of these we are growing the same old stock and using the same old methods of 30, 40 and 50 years ago.

The *Easter Lily* has thrived for decades in Florida. In the country fields there is the *Lilium Catesbaei*, a rather delicate thing, but which may be seen in thousands on a favorable late summer afternoon over the flatwoods country. So it cannot be said that Florida is not a "lily country." The common *Easter Lily* is too erratic and usually too tall for current florist use. Certain strains may grow five to seven feet tall, and others bloom with many flowers on a short stem. Possibly some of the lilies now being developed on the West Coast, as the Croft, Estate or Ace strains might prove of value in Florida for breeding or commercial growing. Some progress is being made in the control of mosaic, "fleck" and other diseases, but the situation remains discouraging.

We don't know enough about hybrid *Amaryllis*, which also has great possibilities as a florist item beyond its present place. The bulbs are currently cultivated like potatoes, solely for size, regardless of the quality of the blooms. A glance at a dozen imported Dutch type hybrid *Amaryllis* bulbs in bloom would show the average Florida grower what is wrong with his *Amaryllis* stock in a large degree. The time will come when the Florida grower will have to provide flower quality as well as large and vigorous bulbs. The average selection of types found in the Mead strain today would be a laughing stock in competition with displays of imported greenhouse *Amaryllis* at any major show. The Dutch growers are accomplishing something in the way of seedling *Amaryllis* coming true to color, too.

It has long been my humble opinion that the state experiment station would serve the growers of Florida most effectively by the establishment of a department of ornamental horticulture and floriculture, which

would take the lead, among other things, in the research and discovery of new material and methods along the line of bulbous plants, etc. I hope that sufficient pressure will be forthcoming from the horticultural interests of the state to bring this important advance into reality before too many years. Then Florida will begin to catch up.

There are numerous bulbs, tubers, etc., which are not raised commercially in Florida but which produce satisfactory results for one or more seasons in gardens over the state. Among them we would mention the De Caen strain of *Anemone coronaria*, or *Poppy Anemones*. These succeed in winter in a well-drained sandy loam, fertile, but not richly manured. *Ranunculus* often do well for one season. *Ornithogalum arabicum*, the Giant Star of Bethlehem, will do well for years if lifted over summer. It has beautiful umbels of white flowers.

The *Gloriosa*, on the other hand, is entirely at home in Florida, so much so that after once growing it in a garden, it is practically impossible to eradicate it. Both species, *Rothschildiana* and *G. superba* are excellent, the former being more showy and effective. It will bloom at any time of the year, while *G. superba* blooms only in late summer customarily. The *Gloriosas* were introduced by Dr. Nehrling years ago. They are bulb vines, and climb by tendrils on the tips of the leaves. *G. Rothschildiana* is being raised at this time for cut flowers, shipped by air to the north. The tubers are L- or V-shaped and grow well in any light, loamy, sandy soil, well drained and preferably upland. On low land they are subject to rots.

The *Polyanthus Narcissus* are very familiar, of course, including the Paper White, Grand Soleil d'Or, Grand Monarque, Chinese Sacred Lily, etc. These have been grown for years in Florida by the acre, perhaps less now than 15 or 20 years ago, when there was a "boom" in "Paper Whites" which was promoted largely on a speculative plane. This will long be remembered with unease by certain growers.

These *Narcissus* like a rich, fertile soil such as is used for white potatoes. They will do fairly well in gardens in any good, well manured land.

*Freesias* will grow and bloom in Florida so well that they might become a weed if it were not for the limiting factor of the root knot nematode, to which they are particularly susceptible. They like a light, sandy soil with some moisture. In *Iris*, we have native species for water gardens in Florida, including the spectacular *Iris tripetala* and *I. savannarum* and occasional rare color types. Many of the rainbow shades of the Louisiana iris, recently described by Dr. John K. Small, are effective in waterside plantings in Florida. The so-called German and Japanese iris are not a success over the peninsula.

The Dutch *Iris*, horticultural types derived from bulbous species native to the Western Mediterranean region, are excellent for cut flower and garden use in Florida, but the bulbs do not last more than one or two seasons, as a rule, succumbing to rots in the hot weeks of late spring before maturing properly. Even when lifted in spring, there is usually a large loss, but the bulbs are inexpensive and their beauty so outstanding that they are well worth trying year after year. The pretty *Allium Neapolitanum* behaves similarly, as do many other charming bulbous subjects from the Mediterranean and African areas.

The white callas, *Zantedeschia aethiopica*, and its semi-dwarf variety, the Godfrey Calla, are handsome and valuable in Florida for the home garden and for commercial flower planting. They are winter and spring blooming, and usually "come back" quickly after a freeze. The Godfrey is most popular in Florida, while the larger *aethiopica* type is more commonly grown in California. The Godfrey is largely grown in Florida for shipping of the flowers.

The yellow (*Z. elliottiana*) and pink (*Z. rehmanni*) callas are showy and effective plants for winter gardens for a season. The bulbs are difficult to hold over.

The *Hemerocallis* or daylily, which is as well known as any tuberous plant, and has recently been enjoying a tremendous increase of popularity nationally as well as in Florida, and it succeeds admirably in Florida, especially the more or less evergreen types. The state experiment station has an important breeding project on this plant, and Florida may be said to have been one of the leading centers of daylily breeding and research in the past 15 years. Prominent among leading workers with this flower have been T. L. Mead, Dr. H. Harold Hume, Prof. E. L. Lord, Prof. John Watkins, Ralph Wheeler, Dr. H. P. Traub and others. The Jacksonville Garden club has contributed materially to its promotion as a fine garden plant in Florida, and our own Lakemont Gardens have produced a few varieties which have met with considerable popular flavor.

*Lachenalia*, *Alstroemeria*, *Hedychium*, various *Zingibers*, *Agapanthus*, *Moraea*, *Oxalis*, *Belemcanda*, *Sauromatum*, *Achimenes*, *Gloxinia*, *Gesnera*, *Amorphophallus*, *Alpinia*, *Cypella*, *Curcuma*, *Ixia*, *Leucojum*, *Eucharis*, *Marjica*, *Hymenocallis*, *Watsonia*, *Leucocoryne*, *Clivia*, *Kaempferia*, *Cannas*, etc., are other subjects to be mentioned in this connection as well worth growing in Florida. As the result of personal experience or the experimentation of other growers in Florida known to us, these can all be recommended for trial. Some of them will need coddling, while others will last for years with little care. In particular I would point to the *Crinum*s and the *Crinum* hybrids as easy bulbs for the garden with abundant blooming rewards for little care and trouble. Many of them are handsome foliage specimens, too.

One of the significant events in the bulb history of Florida was the organization by four plantsmen at Orlando in 1933 of the American *Amaryllis* Society, now the American Plant Life Society, which has published a succession of yearbooks under the name "Herbertia" which contain valuable and informative material on various bulbous

Amaryllids and the Hemerocallis or Day-lily, under the editorship of Dr. Hamilton P. Traub, now with the U. S. Department of Agriculture, in Washington, D. C. This Society has had considerable success in stimulating enthusiasm for the field of bulbous plants.

One of the fascinating facts of bulb culture and experimentation in Florida is the seemingly endless list of new material which

we are anxious to obtain and test for Florida conditions. There is always so much to look forward to seeing and so much work to be done that it keeps one on the alert continually. Never a dull moment. I wish to thank you, Mr. Chairman, for the opportunity to say something in behalf of my favorite subject, and to express to you, ladies and gentlemen, my sincere appreciation for your kind attention.

## THE DISEASE FACTOR IN EASTER LILY BULB PRODUCTION IN FLORIDA

HOWARD B. JOHNSON  
Sebring

Commercial Easter Lily plantings are found in widely separated locations in Florida ranging from Perry in the north to Homestead in the south. However, the largest concentration of plantings is found in the Lake Placid area where acid muck and climatic conditions are generally adapted for the culture of Easter Lilies.

In the past, practically every grower in the area was interested in bulb production rather than the sale of flowers. The commercial bulbs, six inches or larger in circumference, grown in Florida provided the northern greenhouse operators with a large part of their forcing stock. During the war years, with Japanese bulbs off the market, the financial return to the grower was considerable. In good years gross incomes of five to six thousand dollars per acre for commercial bulbs only were common.

The Easter Lily is quite resistant to man-made hazards of cultivation practices. Unfortunately, however, the lily is not resistant to necrotic fleck and other virus diseases.

Necrotic fleck<sup>1</sup> is described by Brierley and Smith as a complex disease, the result of two viruses being present in the plant at the same time. One is apparently limited to

Easter Lilies and is completely symptomless when present alone. The other virus is the common cucumber-mosaic virus. Neither of these viruses injures Easter Lilies materially when present alone but the two in combination produce necrotic fleck. The melon and green peach aphids are responsible for the field spread of the disease.

Necrotic fleck made its appearance in the Lake Placid area in the 1943-44 season. It apparently came in on planting stock from outside the area. Because of their concentration in a relatively small area all fields were affected to some extent within two years after the introduction of the disease. Careful roguing kept the visual infection to a low percentage in most cases. However, late season infections, which are not noticeable until the following growing season, resulted in a carry-over of the disease in the planting stock for the 1946-47 crop year.

This initial source of infection, present in practically every Easter Lily field in Lake Placid and wherever Lake Placid planting stock had been carried, set the stage for a most disastrous year. Summer-like weather, continuing until the freeze

<sup>1</sup>BRIERLEY, PHILLIP, AND SMITH, FLOYD F. Spread of Fleck Disease. *Florist Review* 96 (2491): Aug. 23, 1943. *Florist Exch.* 105 (11):16 Sept. 15, 1945.



in early February, was ideal for large aphid populations. The secondary spread of the disease was impossible to control.

One example is cited. Easter Lilies and cucumbers were planted in adjacent fields separated by a roadway. The commercial bulbs of the previous season showed 1/2 of one percent infection after forcing so the planting stock was fairly clean. The fall crop of cucumbers matured about the time the lilies were nicely above ground. Good roguing failed to keep pace with new infections. Cold injury to the foliage masked the fleck-symptoms so completely that roguing was impossible until new growth made its appearance. To complete the picture was the spring crop of cucumbers. At digging time the visual infection was 80-85 percent.

It is difficult to convince all growers of the importance of necrotic fleck because the disease does not materially affect bulb or flower production in the field. Also, there has been little or no price distinction between clean and infected bulbs.

Necrotic fleck seriously impairs the forcing performance of bulbs under greenhouse conditions. The foliage is unsightly, the flowers are often spotted and many plants come blind.

Repercussions from this past season's bad lot of bulbs will materialize before another crop is marketed.

One can be sure that binder payments of \$500 to \$1000 per acre are things of the past. Likewise there will be a big price distinction between clean and infected bulbs.

The present status of the Florida Easter Lily bulb industry will not improve until the growers realize they must produce a good quality bulb. Bulb buyers are largely responsible for the present condition of the industry. If purchases, in the past, had been limited to clean fields the individual grower would have had an incentive to continue careful roguing.

There are a few isolated plantings of clean bulbs in the State although many plantings, which appeared to be isolated, were "flecked" out this past season. This illustrates the difficulty of growing clean bulbs regardless of the distance to the nearest infected field.

The possible solution is for the growers to organize and request legislation prohibiting the movement of diseased bulbs.

HORTICULTURAL TRADING CO.,

Sebring, Fla.

## NEW DEVELOPMENTS IN INSECTICIDES AND APPLICATION EQUIPMENT

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In 1945 the author presented before the members of The Florida Horticultural Society a paper entitled, "Present Status of DDT As An Insecticide." In this paper an effort was made to present the most pertinent facts pertaining to this compound. Since 1945 research work relative to the

use of this compound has broadened greatly, and the possible uses of this chemical, as an insecticide, have been extended. In 1947 we find a general tendency toward widespread recommendations for the use of various formulations of DDT in the control of pests of garden and truck crops, deciduous fruits, citrus, cereal and forage crops, cotton, forest and shade trees, stored seed, grain, and pests affecting the health and comfort of man and domestic animals.

The advent of DDT upon the world ento-

mological scene stimulated terrific scientific interest in the development of new chemicals; and the uncontested right of this compound for the spotlight in world publicity was soon challenged by other notable chemicals, which have proven to be equally valuable as DDT in some respects and superior in others. This treatise deals with the most promising of these compounds.

*Velsicol 1068 (Chlordane).*—Velsicol 1068 has many characteristics that will encourage its general use in the control of pests. It is a chlorinated hydrocarbon, which has residual action which is not as extended as that of DDT. This compound is insoluble in water, but is readily soluble in the usual organic solvents such as aliphatic, aromatic and chlorinated hydrocarbons, also in ketones, ethers, and esters. The proper formulation of Chlordane will enhance its insecticidal value. Compositions may consist of solutions emulsions, wettable powders, dusts, and aerosols.

The determination of the degree of compatibility between Velsicol 1068 and other spray materials is still elementary and in a state of flux. It is quite evident that it should not be combined with hydrated lime or other alkaline materials in dust or spray formulations as alkaline diluents reduce the toxic affects of this compound.

Velsicol 1068 may be used successfully with DDT, pyrethrum, thanite, and lethanex. Compatibility range of this chemical will be broadened as studies continue.

Velsicol 1068 in sufficient quantities is poisonous to vertebrate animals, including man. The effects of 1068 upon warm blooded animals is comparable to DDT if the comparison is made strictly on a weight basis. Data thus far indicates that Velsicol 1068 may be successfully employed at weaker strength, thereby increasing the safety factor.

Numerous tests relative to the physiological effects of Velsicol 1068 upon plants are being made. Research workers under the author's supervision have conducted numer-

ous tests on the phytocidal action of this chemical. These have included vegetable and field crops, citrus, and ornamentals. Burn records on the plants tested were insignificant. It may be said that plant tolerance for this chemical is exceptionally good.

Velsicol 1068 (Chlordane) is demonstrating a wide range of insect control qualities that is quite comparable to DDT. Thus, this is another chlorinated hydrocarbon which bids well to have a strong impact upon all types of pest control. It has proven to be highly efficacious in the control of disease vectoring and pest mosquitoes, houseflies, fleas, ticks, lice, roaches, bedbugs, and spiders. Sprays containing this chemical may be used as space sprays or residuals. Formulations of Chlordane have been successfully used in the control of grain beetles and moths, carpet beetles, ants, silverfish, fruit flies, and book lice. Wettable powders and emulsions containing Velsicol 1068 may be used in protecting domestic animals from such pests as sucking lice, houseflies, hornflies, mosquitoes, and ticks. Many of the most prominent of the agricultural pests have also submitted to the insect toxic effects of this chlorinated hydrocarbon. Results of an extensive character have not been reported on ornamental shrubs and shade trees. Indications are that successful control of aphids, whiteflies, armored scales, mealybugs, leaf feeders, and others will be possible.

*Dichloro-Diphenyl-Dichloroethane.*—One of the most promising closely related compounds to DDT is dichloro-diphenyl-dichloroethane, which is commonly called DDD, and is sold under the trade name Rhothane D3. This chemical reveals sufficient stability to permit storage under varied conditions but should not be stored in alkaline mixtures.

Toxicological data assimilated thus far indicates that DDD is somewhat less toxic than DDT from an acute and chronic poisoning standpoint. The insecticidal activity

of this compound is superior to DDT in some instances while in others it is reported as inferior.

It has proven to be a rather effective ingredient in cattle sprays. Its reduced toxicological effect might constitute an encouraging factor. It may also be used in powders for application to animals for the control of lice, fleas, and other ecto parasites. It is also proving to be of value in agricultural sprays.

*Hexachlorocyclohexane*.—The chlorinated hydro carbon 1, 2, 3, 4, 5, 6, hexachlorocyclohexane is commonly known as benzene hexachloride or 666. The crude material contains the Alpha, Beta, Gamma and Delta isomers. The Gamma is the most important from an insect toxicity angle and comprises 10-12 per cent of the crude. This isomer was termed Gammexane by one of the early workers. The pure Gamma isomer is a colorless crystal, practically insoluble in water but soluble in organic solvents.

Some of the solvents which may be used in the formulation of benzene hexachloride sprays are as follows: acetone, benzene, carbon tetrachloride, cyclohexanone, diesel oil, ether, ethyl alcohol, xylene. Insecticidal preparations of this material may be as dusts, solutions, emulsions, wettable powders, smokes, or aerosols.

This chemical has revealed a wide range of toxicity to insects. Phytocidal action is rare, and toxicological studies have revealed that it is a safe insecticide for use in the control of insect pests when used with normal safeguards. Research investigations under the author's supervision have revealed that it will effectively control many of the pests of vegetable crops.

*Toxaphene*. — Toxaphene is described chemically as a chlorinated camphene. It is prepared in technical grade and purified forms. This newly developed compound is readily soluble in organic solvents, thereby making the formulation of liquid insecticides and insecticide concentrates easy. It is soluble in water.

Toxaphene may be formulated into oil soluble concentrates, water miscible concentrates, wettable powders, and dusts. Formulation ingredients should not be alkaline in character as this reduces the toxicity of the chemical. It is compatible in chemical formulations containing thanite, pyrethrum, rotenone, DDT, lead arsenate, calcium arsenate, nicotine sulfate, fixed copper fungicides, sulfur, and neutral emulsifying and wetting agents.

Laboratory and field experimentation have revealed its effectiveness in the control of household and storage insects, pests of livestock, pests affecting the health and comfort of man, pests of field crops such as cotton, and pests of ornamental shrubs.

*Ortho Ortho-Diethyl Ortho-Para-Nitrophenyl Thiophosphate*.—This insecticide is very slightly soluble in water. However, it is completely miscible in the majority of organic solvents. It is only slightly soluble to insoluble in petroleum ether, kerosene, and refined spray oils. It is commonly known as Parathion or 3422.

Parathion may be formulated into emulsions, dusts, wettable powders, and aerosols. It demonstrated good insect toxic qualities in laboratory tests. Field tests are now being conducted in all regions. In Florida the first field test with this compound was made under the author's supervision in the shade grown tobacco belt. 3422 revealed the highest toxic efficiency of all insecticides tested for the control of the green peach aphid.

This chemical has approximately the same toxic range to warmblooded animals as nicotine sulfate. Phytocidally it seems to have a safe range on a number of plants; but may cause injury to some when improperly used.

*Hexaethyl Tetrathosphate*. — Hexaethyl tetrathosphate has revealed rather excellent toxic qualities upon aphids and some other species of insects. It seems to have exceptional initial toxicity to aphid species. This compound is very dangerous to warmblooded animals and therefore necessitates

the use of extreme care in manufacture, formulation, and field use.

#### SYNERGISM

Synergistic action of materials added to insecticidal chemicals is a field that interested workers during the war and has been carried over into the post war period. The initial compound produced commercially for this purpose was isobutylundecylencamide. Subsequently there was reported piperine compounds, sesame oil, piperonyl cyclohexenone, and piperonyl butoxide.

Sesame oil, which contains sesamin, was extensively used during the war period as an ingredient in aerosol bombs for the activation of the pyrethrins.

D and O 312, which is piperonyl cyclohexenone has some insecticidal value and also serves as an activator for pyrethrins. It is commonly called PCH by the trade, or Pyrenone. Its synergistic behavior is marked, affecting degree and speed of toxicity of the pyrethrins. Cyclohexenone seems to be activated also by pyrethrin thereby increasing its basic insect toxic quality.

Piperonyl butoxide is another synergist for pyrethrins that has demonstrated basic insect toxic qualities. It is readily soluble in mineral oils used as solvents, and in propellents used in aerosol preparation. It may be used in preparing dusts, wettable powders, or emulsions.

Piperonyl butoxide has a basic insecticidal value and activates and is activated by pyrethrins. Its presence with the pyrethrins seems to result in an extended residual effect. The safety of such combinations increase the usage in domestic areas, and on consumable products.

#### SOIL FUMIGANTS

Advancements have been made in the soil fumigant field that are exceedingly promising. Two of the chemicals that seem destined to play an important part in

the control of soil infesting pests are ethylen dibromide, and 1-2 dichloropropane and 1-3 dichloropropylene mixture. DD is the abbreviated name used in referring to a dark liquid soil fumigant consisting of a mixture of 1-2 dichloropropane and 1-3 dichloropylene. This mixture effectively controls wireworms and nematodes. There is some evidence of carry-over for two years. It may be retained in soil for extended periods, and thereby injure or kill certain seeds and young plants. Some root crops may take up "DD" odor if planted soon after treatment. There is some evidence of accrued value when DD is combined with ethylene dibromide. Dosages range from 200-700 pounds (20-40 gallons) per acre. Spacing should be 16 inches, and a seal is not required.

Ethylene dibromide is another effective fumigant for the control of nematodes and wireworms. This fumigant is less phytocidal than "DD," and may at times be applied to living plants. A dosage of 2 gallons of EDB per acre used in a naphtha base is effective. A range of 1-4 gallons may be employed. Spacing should be 12 inches as diffusion range is narrower. Water seal is not required, and soil should not be too dry or too wet. Dowfume W10 contains 10 per cent ethylene dibromide, while Dowfume W 40 contains 40 per cent.

DD and Dowfume W-10 are most effective when a special applicator is used in making soil treatments. Dowfume W-10 is for small garden plots and does not require a special applicator.

#### DEVELOPMENT AND IMPROVEMENT OF APPLICATION EQUIPMENT

The chemicals discussed have only been a few of the many thousands of organic and inorganic insecticides that have been tested in the field and laboratory during the last eight to ten years. Thus it is revealed that only a comparatively few have proven feasible in the control of our pests. Unquestionably many additional chemicals will be added in future years. Problems per-

taining to the most effective use of these insecticides will arise and require patient investigations by many scientists.

If a full realization of the effectiveness of newly developed chemicals is to be attained it is essential that application equipment keep pace in this period of progress. This is true in order that applications may be made with the least labor and costs. Three important factors involved in the application of insecticides are dosage control, uniformity of application, and proper placement or coverage. These are functional requirements of equipment.

Improvements in existing equipment include hydraulic lifts for tower units which permit them to be pivoted and laid down to facilitate travel along roads. The development of the vertical multiple-nozzle boom increases the speed and effectiveness of spray applications by facilitating the coverage of the sides and crowns of trees.

In the field of newly developed application equipment there are many interesting trends. Some of the most important follow:

*Sprayer-Duster.* — The sprayer-duster combination permits the application of dust or liquid spray alone or in combination. When the two are applied simultaneously the liquid acts as a sticker for the dust. These are one man machines which permit the coverage of 4-15 acres per day. These outfits utilize a high air velocity resulting from a 12-inch fan operating at 4000 rpm, driven by a 4-6 horsepower air cooled engine. This insures an equalization of air currents. The dust is usually directed into the blower or fan of the machine, while the liquid is applied in small quantities at outlets of air stream.

*Speed Sprayer.*—The speed sprayer is another addition to modern application equipment which utilizes an airplane-propeller blast which moves large volumes of air at low velocities. The usual dilute spray material is used, and the air blast creates a

heavy mist which is driven through the foliage.

*Aerosols.*—The use of Aerosols were popularized during the war period. This type of aerosol utilizes such chemicals as dichloro-difluoro-methane (Freon 12) as a propellant, and pyrethrins and other materials as toxicants. Their usage is well established. The use of this application method is being extended into the greenhouse and on field grown plants. The utilization of methyl chloride as a propellant has facilitated the broadened use of this method as larger particle size is required.

*Fog Generators.*—Following the development of the aerosol method came the steam aerosol or fog applicators. These use concentrated sprays which are atomized into steam or hot air which create a vapor. This vapor condenses under atmospheric conditions and is aided in its movement as a fog by air currents. These machines have attracted widespread attention but remain somewhat in an early experimental stage.

*Mist Blowers.*—Another piece of insecticide application equipment which was advanced during the war period is the Mist Blower. The mist blower utilizes an engine-driven turbine (blower) which develops air currents of high velocity. The current of air is "straightened" and channeled through a series of baffle-plates into the barrel or dispersal gun. Concentrated sprays are used and these are finely atomized by the air currents, and propelled considerable distances. Coverage is excellent.

*Aircraft.*—The dispersal of insecticides by airplane, autogiros, and other machines is progressing along stable lines. This method will receive greater play in the future as methods and materials are perfected. This is true especially in large areas devoted to specialized crop production and inaccessible areas which prohibit the use of ground equipment. Aircraft applications remain in an experimental stage.

## LOOKING FORWARD

In reviewing the literature it is emphatically revealed that newly developed chemicals possess a wide range of toxicity and effectiveness. This fact justifies in part the enthusiasm with which some scientific people have endorsed and recommended general usage. However, complexities resulting from general usage are beginning to appear and may in time reflect badly upon those who have been too hasty in their appraisals. Requirements for the wide-spread use of newly developed chemicals are: safety to soils; safety to public health; safety to plants; safety to farm animals; safety to beneficial insects; and safety to wildlife. Such complete information has not been obtained thus far for the newly developed insecticides.

Indications of troubles arising from ill advised use of chemicals are classically illustrated by the possible effects upon the soils. DDT may tend to retard plant development when used at certain rates. The retardation effect may depend upon the degree of acidity or alkalinity of the soil,

or the amount of organic material or colloidal clay that is present.

Data is rapidly being recorded that indicates the tremendous toxic effect that newly developed chemicals have upon the parasitic and predaceous enemies of economic insect species. Thus has been demonstrated the abnormal increase of scale insects on citrus, aphids on deciduous fruits, and pests of vegetables due to the heavy destruction of beneficial species. This upsets the biotic complex to such a point as to endanger crop production. Time must be taken in the detailed investigation of all problems involved in the use of such chemicals.

It is quite evident that we are well advanced into a new insect control era. We are well equipped, for this period in human affairs, with great Industrial Agencies staffed and equipped for the synthesis and manufacture of new chemicals, and with thousands of well trained entomologists who ask mainly for the opportunity to serve. If provision is made for the proper appraisal of these new developments it will result in a worldwide advancement of civilization.

## FLOWERING TROPICAL TREES—A PLANTING PROGRAM FOR FLORIDA

By EDWIN A. MENNINGER  
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Stuart

Florida needs a well-rounded program of ornamental tree-planting. There are three distinct zones in this state: north Florida with its usually acid soil and temperatures as low as 18 degrees; central Florida with its neutral, or sometimes acid soil, with temperatures as low as 25 degrees; and south Florida, with its predominantly limestone soil and a minimum temperature of 32 degrees.

For each of these areas it is necessary to work out a schedule of the trees best

suited for special purpose planting, particularly highways, parkways, yards, parks, cemeteries, community forests, special locations on the waterfront which are exposed to high winds, salt spray, or occasional inundation, and lastly, trees which best resist hurricane winds.

In working out such a schedule, we should consider trees that provide a combination of shade and flowers, those that are particularly useful in providing shade, those that are distinguished mostly for their showy flowers, and those which, like mahogany, the tung oil, and many similar trees, can be planted with the thought of timber or nut crops.

Progress in working out a program of ornamentals is slow because, to begin with, there is no immediate dollar appeal. Economic factors have promoted extensive research and experimental planting in connection with fruit and timber crops in Florida, but there are no funds for trial efforts with ornamental trees. Even the University of Florida Experiment Station at Homestead gets insufficient money from the Legislature to provide one single horticulturist to study ornamental trees, and there are too few horticulturists in private life in Florida who are able to devote their efforts to the esthetic field.

Inadequately explored is the field of propagation. It is hard to get tree seeds from abroad, and many that do come in lose their viability in transit because tropical seeds are notably short-lived. Many introduced trees fail to bear seed when planted in Florida, perhaps because of the absence of the requisite pollinating agency. Moreover, methods of propagation used for other plants are often unsuccessful in growing tropical trees. Considerable research needs to be done in this field, and it is noteworthy that the University of Miami has added a research staff this year to make studies in this particular field.

Entirely unexplored is the matter of vegetative propagation, which is the only manner in which we can get the choicest and surest flowering strains in our tropical plants, and it is the only way in which we can develop root systems suitable for some parts of Florida. For example, in south Florida, where the water table is within a few feet of the surface of the ground, deep-rooted trees will not grow. And it is necessary in these areas to do considerable experimental work to ascertain which root stocks with shallow, spreading root systems are best adapted for growing the flowering trees suited to the locality.

More different kinds of trees are under cultivation today in Florida than in any other State in the union. Besides 300 native trees, there are 800 exotic shade and

ornamental trees in various stages of introduction in Florida and more than 200 species of fruit trees—1300 in all, But these represent less than one-third of what can be grown here, and there is a tremendous unexplored field in new trees which Florida can use to bring to life its millions of idle acres.

In this vast forest, too large for any individual to encompass without getting lost in the woods, my special interest has been in trees that are distinguished by their showy flowers. Excursions through the floras of tropical countries reveal that there are more than 3,000 trees worthy of being classed as "flowering trees," in that their bloom is a conspicuous and interesting phase of the tree's growth and development. Of these 3,000 trees, not more than 500 have ever been introduced into the United States or any effort made to study them with reference to their usefulness as ornamentals. They are not trees which promise dollar returns, vast crops or extensive orchards, and consequently they fail to appeal to an economic-minded generation. However, these flowering trees do create a soul-stirring beauty, they do provide charm for our landscape, and they add lasting value that is measured in satisfaction rather than in money.

I call these flowering trees "the bouquets of the giants."

We, in the United States, have so much to learn about the beautiful trees which grow in other countries that it is difficult for us to take a starting place. Yet, in the limited scope of this paper, I venture to suggest at least thirty magnificent flowering tropical trees that deserve extravagant effort to introduce and establish in Florida for the beautification of our State. I shall ignore the many beautiful flowering trees we already have and attempt to stimulate your imagination and challenge your ingenuity to help bring to the Florida landscape some or all of these beautiful trees.

Let us begin with South America. On the western slopes of the Andes, in the sub-

tropical parts of northern Chile, there are two trees of exceptional merit. One is called the Evergreen Hazel (*Guevina avelana*) which is described by one authority as "one of the most beautiful of all trees," with snow-white flowers in spikes. From the same country comes report of a tree the Chileans call Firebush (*Embothrium coccineum*). One botanist has reported that it is "perhaps the showiest tree in the world."

Such expressions take in too much territory, because from time to time in other tropical countries, plant explorers have found trees which they, in turn, have described with equal enthusiasm. For example, a good many years ago, the great botanist Hooker expressed the opinion that the most beautiful flowering tree in the world was *Magnolia campbelli*, with its 12 inch pink flowers, and that the second most beautiful was the Indian tree *Talauma hodgsoni*, with its bell-shaped creamy white flowers. But even these two trees, fine though they are, must take a back seat when their beauty is compared to some of the other genera that have been observed more recently in other countries. For example, passing eastward over the Andes into the sub-tropical and tropical parts of northern South America, particularly Brazil, Colombia, and the Guianas, explorers have reported exceptionally beautiful trees of top rank. I might cite two or three examples from that area.

Adolph D. Ducke, famed Brazilian botanist, has done more to call the world's attention to what Brazil has to offer than anybody else, and his pick of the most beautiful trees to be found in that part of the world belong to two genera we in the United States have never even heard of. One of these is the genus *Elizabetia*, and the other in the genus *Eperua*. These to us are only strange names. But there are a good many kinds of *Elizabetia* and a good many kinds of *Eperua* trees, some of them outstandingly beautiful, and offering great possibilities for use as ornamentals.

However, the Brazilian authorities do

not agree. The Brazilian Government, through its Department of Agriculture, has twice published a book illustrated in color portraying the beautiful flowering trees of Brazil and it is noteworthy that the trees described in those books and pictured to best portray their beauty, include not the two choice genera suggested by Ducke, but instead we find presented trees of undoubted merit and certainly of great beauty in the pictures, with such strange names as *Mol-denhaurca*, *Uochysia*, *Macrolobium*, *Caly-cophyllum*, etc.

Many Floridians are familiar with the Queen's Crapemyrtle (*Lagerstroemia speciosa*), an Indian tree which is beginning to be widely planted in south Florida and, as it does well here, it has become more and more popular for its lovely flowers, even if they do come in the summer time when tourists are not here. However, in the lowlands of eastern Peru where the climate is similar to ours, there grows another tree which in its general aspect resembles the Queen's Crapemyrtle, but is possibly better suited for ornamental planting because the flowering season is much longer, often three months, and the profuse blossom with bright pink petals and dark purple calyx, offers a dazzling appearance at a flowering season which in Florida probably would be between January and March when the tourists are here to enjoy the bloom. The name of this tree in Portuguese is Pau de rosas and the botanical name is *Physocalymma scarberrimum*. Presumably, if we could get it established in the United States, we would call it by some simpler name.

There is another Brazilian tree, *Sparatospasma vernicosum*, which Rock, the famous Hawaiian botanist, once referred to as "a magnificent spectacle when in full bloom and certainly deserving to be cultivated."

Over in Hawaii, where most of the cultivated plants are native of some other part of the world, they do have a few outstanding showy flowered trees which are indigenous in the islands and which are quite unknown elsewhere in the world. I







refer particularly to *Kokia*, with its splendid red blooms, and to a *Clermontia* tree which is exceedingly handsome with dark purple flowers. The tree which the Hawaiians call Naenae, (*Dubautia plantaginca*), is striking when in full flower, with yellow blossoms in great 10-inch clusters sticking up beyond the foliage. Occasionally, these flowers are purple rather than yellow.

Australia has several offerings. We are familiar with many beautiful Australian trees, but strangely enough two or three of which they are particularly proud, are entirely unknown in the United States. We do not know at all their Christmas tree, *Ceratopetalum gummifcrum*, which is used out there as we use holly. I have in mind, too, the *Eucalyptus pruinosa*, a species which Charles Barrett in his book "Pacific Wonderland" refers to as "whose huge crimson blossoms are among the world's most wonderful flowers." We are entirely unacquainted with the Australian Firetree, *Vuytsia floribunda*, which is exceedingly fine, and Queensland's pride, *Barklya syringifolia*.

India has given us a number of beautiful trees that are in common cultivation but we in the United States are quite ignorant of the beauty provided by *Mesua ferrca*, widely planted as a street tree in India and throughout the East Indies because of its exceptional beauty. We also are unfamiliar with *Tecomella undulata*, which produces enormous quantities of bright orange flowers in clusters, very similar to some of our *Tabebuia* trees, to which it is related.

In New Zealand, the most beautiful flowering tree they have, they call Hinau, (*Elacocarpus dentata*); it covers itself with saucer-shaped flowers, creamy white like lilies-of-the-valley.

From west tropical Africa I would mention only three among hundreds of beautiful trees; *Baikiaca insignis*, which has enormous snow-white flowers 10 inches across, the largest blossom to be found on any plants of the legume family; *Lophira alata*, with its clouds of white blossoms; and

*Neobouldia lacris*, which bears pink trumpet-shaped flowers in great clusters. It is referred to in one book about the plants of the Gold Coast colony as "flowers, purple, and bell-shaped, and very beautiful." Purple and pink are often so closely related that the discrepancy is understandable.

From Java I have selected only one of a hundred beautiful trees described by Corner in his splendid book, "Wayside Trees of Malaya." This is the yellow Pagoda flower tree, (*Deplanchea bancana*), whose clear yellow flowers appear in long dense umbrella-shaped clusters and Corner says of it: "This beautiful tree is included in this book because it offers in bloom such a wonderful sight, the light green crown being decked with pyramids and pagodas of yellow flowers."

Central America offers a profusion of beautiful trees which we know nothing about. I particularly want to call attention to *Symphonia globulifera*, which, when it is in flower, at a distance resembles a cherry tree full of red cherries, because the branches are heavily laden with bright red flowers in terminal clusters, each flower rather small but the over-all effect exceedingly showy and ornamental.

Guatemala is distinguished for beautiful trees. I might refer here to *Robinsonella*, of which one botanist has written: "They are a beautiful sight when in full bloom in March and April, being covered with small clusters of pendent bell-shaped flowers whose ground color is white but so strongly veined with bright purple as to appear more purple than white." Also distinguished for its beauty is *Bernoullia flammea*, which is wide spread in Central America. These trees are leafless during the dry months but they blossom at the beginning of the rains, and then attract attention because of the bunches of small but brilliant, flame-colored flowers.

*Wigandia* is another handsome tree with large velvety leaves and great masses of bright purple flowers. *Astianthus*, native of southern Mexico, often forms dense

thickets and the trees are conspicuous because of their bright green foliage which contrasts in dry seasons with the sparse, withered vegetation on the surrounding hillsides. The trees are even more conspicuous when in blossom, producing many clusters of very large, bright yellow flowers, similar in form and size to those of *Catalpa*.

All of these—and I have overlooked some of the finest of all—*Brownea*, *Jackia*, *Erythrichia*, *Phlebotaenia*, *Saraca* and so on—are only names which today are a jargon as unintelligible as a foreign tongue, but which tomorrow may be keys to a more beautiful landscape in Florida.

There is a practical application of all these facts about trees to our situation in Florida. When a newcomer arrives in this state to build and landscape a home, he is confronted with a vast body of tropical plants with which he is entirely unfamiliar and he is immediately confused by the maze he finds on every side. If he ever needs help, it is then. He can, and usually does, go to a nurseryman to advise him, and that nurseryman sells what he has on hand, without regard to landscaping as an art and without reference to the enormous body of tropical plants that are available or should be available to the householder who is interested in making the most of his new opportunity.

We very much need a campaign of public education to acquaint would-be home owners, as well as others who want to learn, with the trees and other plants which have been tried and found most satisfactory for specific purposes. If such a list were prepared by a representative committee of plantsmen from north, central and south Florida, and could be placed before the public with the sponsorship of the Florida State Horticultural Society, this would be a definite step to assist newcomers in becoming acquainted with the flora of our state.

In California, leadership in this field has been taken by the California Association of Park Administrators, who have prepared a list of 65 trees suitable for parkway planting in the southwestern United States. This

published list gives the botanical and common names of the tree, the type, whether evergreen or deciduous, conifer or palm, the habit of growth, the stature of the tree, the type of foliage, the color of the flower, the rapidity of growth, the adaptability as to seashore or inland, the soil requirements, the preferences as to frost, wind, and moisture, the useful life of the tree, the width of parkway, the distance apart to be planted, and the cost to maintain.

It is my suggestion that a similar chart be prepared for Florida, setting up a group of trees recommended for highway planting in south Florida, a group recommended for this purpose in central Florida, and a group for north Florida. The same schedule would present a group of trees suitable for yard planting in south Florida, a group recommended for central Florida, and a group for north Florida. The same thought could be carried a little further to other specific purposes where trees are needed on our landscape, and only by such suggestion and constructive effort to educate the public on available trees which do best under certain conditions, can we ever bring many fine new species into general cultivation in Florida.

The public wants to know what trees to plant and there is a constant flow of inquiries to persons who are studying the possibilities in this field for lists of trees suitable for specific purposes in certain locations. Often it is difficult for a homeowner to get anybody to tell him what trees are best for salt spray areas, or extra low ground, or extra high sandy land, or what trees suffer least from hurricane winds, or what trees have edible foliage and hence are suitable for pasture planting. Inquiries of this sort would be largely answered by the right kind of a tree planting chart based on the experience of men who have spent their lives learning about the adaptability of certain trees to Florida conditions and a great public service could be rendered by this society, by the sponsorship of such a tree planting recommendation.



# FLORIDA STATE HORTICULTURAL SOCIETY

## *Report on Examination*

October 21, 1947

A. GILBERT LESTER  
*Certified Public Accountant*  
WINTER HAVEN, FLORIDA

October 23, 1947.

Honorable Frank L. Holland,  
Treasurer,  
Florida State Horticultural Society,  
Winter Haven, Florida.

Dear Mr. Holland:

In accordance with your request, we have made an examination of the books and records maintained by you as Treasurer of the Florida State Horticultural Society for the period from April 26, 1946, to October 21, 1947, and now take pleasure in presenting our report, together with the following statements:

Exhibit "A"—Statement of Financial Condition—October 21, 1947.

Exhibit "B"—Statement of Receipts and Disbursements for the Period April 26, 1946, to October 21, 1947.

Exhibit "C"—Statement of Receipts and Disbursements—Endowment Fund—Period April 26, 1946, to October 21, 1947.

Exhibit "D"—Statement of Income and Expenses—Period April 26, 1946, to October 21, 1947.

Exhibit "E"—Schedule of Bonds Showing Maturity Value and Value to August 31st, 1947, with accrued interest.

Included in the disbursements were premiums paid regarding Fire Insurance coverage in the amount of \$4,000.00 expiring

November 5, 1947, on books stored in buildings numbered 2 and 3. This coverage was later reduced to \$1,000.00 and a refund made of the difference in premium. Premiums were also paid to the surety company covering a bond on the treasurer in the sum of \$5,000.00. Funds on deposit of \$1,782.07 were verified with the bank statements. The U. S. Savings Bonds having a total maturity value of \$11,025.00 which are carried on the books at a value of \$8,246.75 were verified by direct examination on the morning of October 14, 1947. It is to be noted that purchases were made in April and May, 1947, of U. S. Savings Bonds having a maturity value of \$5,600.00, at a cost of \$4,884.00.

This transaction was handled by the sale of earlier bonds maturing in May, 1947, to the value of \$4,100.00, plus a transfer of funds from the savings account to the checking account of the difference, namely, \$784.00. A detailed schedule of the bonds is included under Exhibit "E."

We would suggest in connection with the posting from the Cash Journal to the General Ledger that it would be advisable to separate the checking account and the savings account into separate columns in the Cash Journal. This would minimize the possibility of errors in posting and establish a definite relationship between the Cash Journal and the respective bank accounts in the General Ledger.

By reference to Exhibit "A," it may be noted that the financial position of the Horticultural Society has been strengthened during the period under review, as the assets show an increase of \$1,205.90 and now total \$10,028.82.

Statements reflecting the receipts and disbursements for the period through the checking accounts and the endowment account appear on Exhibit "B" and "C" respectively and prove the bank balances.

Statement Exhibit "D" sets forth the income and expenses for the period through the checking fund and it is to be noted that expenses incurred exceeded income in the amount of \$344.02. As indicated on Exhibit "D", the largest single item of expense is in the Proceedings expense account which consisted in the main of disbursements made in 1946 for the 1945 proceedings and in 1947 for the 1946 proceedings. A net total of \$3,569.72 was expended on these items.

Our audit consisted of checking all duplicate receipts issued for memberships and the income to the Cash Journal and also

checking all disbursements to the Cash Journal and scrutinizing the checks and vouchers for signatures, endorsements and distribution. We checked all entries posted to the General Ledger and ascertained that the books were all in balance. Included as a supplement to Exhibit "B" is a statement of receipts and disbursements regarding the Secretary, Mr. Ralph Miller.

We posted the adjusting and closing journal entries to the general ledger and brought forward to commence the new period, all accounts having open balances which places the records in good condition for the new Treasurer.

Respectfully submitted,

A. GILBERT LESTER,  
*Certified Public Accountant.*

## EXHIBIT "A"

FLORIDA STATE HORTICULTURAL SOCIETY  
*Treasurer's Funds*  
 STATEMENT OF FINANCIAL CONDITION

## ASSETS

## FUNDS ON DEPOSIT

Checking account .....	\$ 1,630.22	
Savings account .....	151.85	\$ 1,782.07

## ENDOWMENT SECURITIES

U. S. Savings Bonds—par value.....	\$11,025.00	
Purchase Price of Bonds.....	7,502.50	
Interest accrued to August 31, 1947.....	744.25	8,246.75
TOTAL ASSETS .....		\$10,028.82

## CAPITAL ACCOUNT

Balance April 26, 1946.....	\$ 7,729.34	
Interest earned .....	6.25	
Interest on Bonds accrued to August 31, 1947.....	744.25	
	\$ 8,479.84	
Less: Excess of Expenses over Income as per Exhibit "D"....	344.02	\$ 8,135.82

## MEMBERSHIPS

Life Memberships .....	\$1,026.00	
Patron Memberships .....	700.00	
Contributions .....	167.00	\$ 1,893.00
		\$10,028.82



EXHIBIT "B"

## FLORIDA STATE HORTICULTURAL SOCIETY

*Treasurer's Funds*

## STATEMENT OF RECEIPTS AND DISBURSEMENTS

April 26, 1946, to October 21, 1947

## RECEIPTS

*Memberships*

Annual .....	\$1,535.80	
Sustaining .....	1,150.00	\$ 2,685.80
Proceeding Sales .....		228.00
Ralph Miller, Secretary (see Analysis below).....		964.00
Transfer from Savings re Bond purchases.....		784.00
Bond Maturity .....		4,100.00
		<hr/>
Total Receipts .....		\$ 8,761.80
Balance on hand April 26, 1946.....	1,974.24	\$10,736.04

## DISBURSEMENTS

Stationery and supplies .....	\$ 143.06	
Telephone and Telegraph.....	37.94	
Miscellaneous expense .....	381.40	
Proceedings expense .....	3,569.82	
Convention expense .....	87.70	
Purchase of Bonds .....	4,884.00	9,105.82
		<hr/>
Balance on hand October 21, 1947.....		\$ 1,630.22

## ANALYSIS OF RECEIPTS AND DISBURSEMENTS

RE RALPH MILLER, SECRETARY <sup>1</sup>

## RECEIPTS

May 6, 1946—Transfer from Col. Floyd's account.....	\$ 594.50	
May 8, 1946—222 Annual Subscriptions.....	444.00	
8 Sustaining .....	80.00	
1 Proceedings .....	2.00	
212 Banquet Tickets .....	848.00	\$ 1,968.50

## DISBURSEMENTS

May 8, 1946—Advanced to Mercer.....	\$ 200.00	
Banquet Tickets .....	894.50	
Mrs. Butler's Room .....	10.00	1,004.50
		<hr/>
Balance Received .....		\$ 964.00

EXHIBIT "C"

# FLORIDA STATE HORTICULTURAL SOCIETY

## *Endowment Fund*

### STATEMENT OF RECEIPTS AND DISBURSEMENTS

#### April 26, 1946, to October 21, 1947

## RECEIPTS

<i>Memberships</i> —Contributions .....	\$	153.00	
Life .....		450.00	
Patron .....		200.00	\$ 803.00
Bank interest .....			2.67
			<hr/>
Total Receipts .....	\$		805.67
Balance on hand April 26, 1946.....			130.18
			<hr/>
	\$		935.85

## DISBURSEMENTS

Transfer to Checking Account re Purchase of Bonds..		784.00
		<hr/>
Balance on hand October 21, 1947.....	\$	151.85
		<hr/>

EXHIBIT "D"

*Treasurer's Fund*

### STATEMENT OF INCOME AND EXPENSES

#### For the Period April 26, 1946, to October 21, 1947

## INCOME

<i>Memberships</i> —Annual .. . . .	\$1,535.80	
Sustaining .....	1,150.00	\$ 2,685.80
Proceeding Sales .....		228.00
Receipts from officers—Secretary, Ralph Miller.....	964.00	\$ 3,877.80

## EXPENSES

Convention expense .....	\$ 89.70	
Miscellaneous expense .....	381.40	
Proceeding expense .....	3,569.72	
Stationery and supplies .....	143.06	
Telephone and telegraph .....	37.94	4,221.82
		<hr/>
Excess of Expenses over Income.....		(\$ 344.02)
		<hr/>

## EXHIBIT "E"

FLORIDA STATE HORTICULTURAL SOCIETY  
 SCHEDULE OF BONDS SHOWING MATURITY VALUE AND  
 VALUE TO AUGUST 31, 1947, WITH  
 ACCRUED INTEREST

Bond Schedule		Issue Date	Maturity Value	Value 10/31/47
5 x	\$1,000.00 U. S. Series F.	June, 1947	\$ 5,000.00	\$ 3,700.00
1 x	500.00 U. S. Series F.	June, 1947	500.00	370.00
1 x	100.00 U. S. Series F.	June, 1947	100.00	74.00
1 x	1,000.00 U. S. Series F.	April 1, 1947	1,000.00	740.00
1 x	500.00 U. S. Series F.	April 2, 1942	500.00	398.50
1 x	100.00 U. S. Series F.	June 1, 1945	100.00	74.50
2 x	500.00 U. S. Series F.	June 1, 1945	1,000.00	745.00
1 x	1,000.00 U. S. Series F.	June 1, 1945	1,000.00	745.00
5 x	25.00 U. S. Series F.	August 1, 1943	125.00	95.85
2 x	100.00 U. S. Series F.	August 1, 1943	200.00	153.40
1 x	500.00 U. S. Series F.	August 1, 1943	500.00	383.50
1 x	1,000.00 U. S. Series F.	August 1, 1943	1,000.00	767.00
			<u>\$11,025.00</u>	<u>\$ 8,246.75</u>

Cost of Bonds as per Ledger, May 31, 1946.....\$ 6,719.50

Plus Cost of Bonds purchased, 1947..... 784.00

\$ 7,502.50

Accrued Interest to August 31, 1947..... 744.25

Total Bond Value to August 31, 1947.....\$ 8,246.75

## REPORT OF RESOLUTIONS COMMITTEE—60TH ANNUAL MEETING OF FLORIDA STATE HORTICULTURAL SOCIETY

St. Petersburg, Fla.

October 30, 1947.

WHEREAS, citrus canker, a highly infectious bacterial disease affecting citrus trees and fruits, was introduced into the United States about 1910 and shortly thereafter became widely disseminated in citrus plantings throughout the Gulf States; and

WHEREAS, citrus canker was responsible for the destruction of 15,243 bearing, and 342,260 non-bearing, citrus trees and the expenditure for eradication purposes of \$1,070,590 from federal, \$1,264,366 from State, and \$85,000 from private sources in Florida alone; and

WHEREAS, as the result of cooperative activities participated in by representatives of the United State Department of Agriculture and officials of the affected states, official announcement was made of the eradication of the disease from the States of Alabama, Florida, and Mississippi some fifteen years ago; and

WHEREAS, completion of eradication of citrus canker from the States of Louisiana and Texas has not been possible by reason, among other things, of the inability of the Secretary of Agriculture to continue eradication activities through absence of appropriations for this purpose; and

WHEREAS, the continued presence of citrus canker in any property in the United States constitutes a grave menace to the well-being of the nation's citrus industry;

THEREFORE BE IT RESOLVED by the members of the Florida Horticultural Society, in meeting assembled at St. Petersburg, Florida, this 30th day of October, 1947, that the Secretary of Agriculture be requested

and urged to prepare, and the Directors of the Budget to approve, for submission to Congress, estimates in a sum believed sufficient to reactivate the state-federal citrus canker eradication project in Louisiana and Texas to the end that this disease be eliminated from the citrus plantings in these two states and the menace to our citrus industry removed; and

BE IT FURTHER RESOLVED that the Society's Secretary be, and hereby is, instructed to send copies of this resolution to the Secretaries of the Florida Citrus Commission with the suggestion that similar resolutions be adopted and sent to the Secretary of Agriculture and the Director of the Budget, to members of our State Congressional Delegation, and to quarantine officials of the nation's citrus-producing states.

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WHEREAS, spiny citrus whitefly, or blackfly (*Aleurocanthus woglumi* Ashby), a major pest of citrus trees that has demonstrated its destructive nature in the Canal Zone, Cuba, the Bahama Islands, and elsewhere, where it was responsible for the death or serious injury to citrus and other plants of economic importance, has recently become well established in Mexico; and

WHEREAS, blackfly is spreading northwards through Mexico at a rate of speed sufficient to convince state quarantine officials and growers that unless its northward spread is stopped at an early date the insect will soon become established in California, Arizona, New Mexico, and Texas, and subsequently into other southern states with serious economic consequences; and

WHEREAS, it has been demonstrated in Cuba that blackfly can be effectively con-

trolled through the introduction of parasites and predators, and in Key West, Florida, that it can be eliminated through repeated application of an oil spray; now, therefore

BE IT RESOLVED that the Florida Horticultural Society, in meeting assembled at St. Petersburg, Florida, this 30th day of October, 1947, requests the Secretary of Agriculture to enter into cooperative agreements with the Government of Mexico to the end that blackfly be eradicated or brought under control in Mexico at an early date; or, in the event that such agreements have been entered into, that the work be intensified and prosecuted to the end that this menace to southern horticulture be eliminated as promptly as possible.

AND BE IT FURTHER RESOLVED that the Society's secretary be, and hereby is, instructed to send copies of this resolution to the Secretaries of the Florida Citrus Commission with the suggestion that similar resolutions be adopted and sent to the Secretary of Agriculture and the Director of the Budget, to members of our State Congressional Delegation, and to quarantine officials of the nation's citrus-producing states.

WHEREAS, constantly increasing production of Florida citrus fruits necessitates research into questions connected with packing and processing our crops, and

WHEREAS, our citrus experiment station has accumulated a library and notes on experiments which are priceless, and which heretofore been kept in an inflammable building.

NOW THEREFORE BE IT RESOLVED, that the Florida State Horticultural Society assembled in St. Petersburg, Florida, this October 30th, 1947, for its sixtieth annual meeting, extends its thanks to the State Improvement Commission, to the State Board of Control, and to the State Budget Board for having provided the citrus industry with an Experimental Packing House, an Experimental

Processing Plant and a fireproof combination Library and Administration Building at the Citrus Experimental Station.

WHEREAS, it has been recommended by air transport agencies that baggage carried by passengers from foreign countries and possessions destined for points on the mainland via Puerto Rico, be inspected at San Juan P. R. and no further inspections be made following arrival in the U. S.; and

WHEREAS, a procedure of this kind is likely to permit the entry into the U. S. of plants and plant products infected with alien plant pests capable of causing serious economic losses; now, therefore

BE IT RESOLVED by the Florida Horticultural Society in meeting assembled at St. Petersburg, Florida, this 29th day of October, 1947, that a protest against the elimination of the inspection of baggage at ports of entry in Florida be registered with John Allison, Assistant Secretary of Commerce, Washington, D. C., and furthermore, that Mr. Allison be requested to submit any proposed changes to the President of the Florida State Horticultural Society and the State Plant Board of Florida for their study and comment before such changes are put into effect.

WHEREAS, it is a matter of record that the movement of infected plants and plant products is the most potent means of transporting and disseminating insects and diseases affecting plants and trees; and

WHEREAS, the great expansion of international travel and commerce by airplane has opened wide the avenues for the entry into Florida of foreign plant pests capable of causing serious losses to the State's agricultural and horticultural interests; now, therefore

BE IT RESOLVED that the Florida State Horticultural Society assembled for its 60th annual meeting at St. Petersburg, Florida, this 29th day of October, 1947, urges constant vigil on the part of the State Plant

Board to prevent the entry of pests into our state, and urges the State Legislature to provide the Plant Board with funds necessary to employ an adequate inspection force to give us the protection we so urgently need

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WHEREAS, Frank L. Holland is retiring from the office of Treasurer of the Florida State Horticultural Society after nine years of faithful and devoted service in that capacity, and

WHEREAS, during that period, by his diligence, untiring efforts and effective management of the finances of the Society, he is leaving the organization in an excellent condition—

BE IT HEREBY RESOLVED that the Florida State Horticultural Society extend to Frank L. Holland their appreciation and heartfelt thanks for the fine service he has rendered to the Society during his term of office

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The members attending the 60th Annual Meeting of the Florida State Horticultural Society in St. Petersburg, Florida, October 28, 29, and 30, wish to express their thanks to the following:

1. Mayor B. B. Blackburn.
2. Reverend Arnold Charnock, Pastor of St. Bartholomew Episcopal Church.
3. St. Petersburg Chamber of Commerce, particularly their manager, William F. Davenport, Jo Frohock, Director Convention Bureau, and Mrs. Evelyn Corl and Miss Mary MacPhail, who so ably took care of our registration.
4. Especially John J. Dewey, Manager of the Soreno Hotel, and his staff for their courtesy and efficient services.
5. St. Petersburg Times and The Evening Independent and to Pressly Phillips, City Publicity Director.
6. Sheriff Todd Tucker for his parade escort.
7. City Recreational Department for courtesies at Pasadena Country Club.
8. Norman Brown and staff at Radio Station WSUN for publicity prior to the convention and for time on the air during the meeting.
9. H. H. Constantine, President of Constantine Farms, Inc., for furnishing flowers for the speakers table, in the rooms and for the banquet.

Respectfully submitted

RESOLUTIONS COMMITTEE.

## REPORT OF THE NECROLOGY COMMITTEE



CHARLES HILLIARY WALKER

Charles Hilliary Walker passed away October 12, 1947, at his home in Bartow, Florida, at the age of 76.

The life of Charles Hilliary Walker is the story of the beginning and the development of the cooperative movement in the Florida citrus industry. For 40 years he had devoted himself to the development of this industry and its cooperative organizations.

Born in Taylor County, Georgia, on December 24, 1871, Mr. Walker's parents moved to Bartow, Florida, in December, 1886, where Mr. Walker still had his home at the time of his death.

Mr. Walker built a packing house at

Bartow in 1901, which he operated until 1907.

In the summer of 1907, Mr. Walker organized three cooperative packing associations of citrus growers in Polk County, at Florence Villa, Bartow and Homeland. These associations prepared the fruit of their members for shipment.

In early 1909, he helped to organize a party of 40 Florida growers which went to California to study that State's method of selling citrus fruits cooperatively. He returned to Florida in May of that year, while the State Legislature was in session, and helped to get the State's law-makers to enact the first Florida Cooperative marketing act. He then served as secretary of the organization committee which, in June, 1909, formed the Florida Citrus Exchange.

He became general manager of its Polk County Citrus Sub-Exchange, and undertook to organize the growers of Florida's citrus producing district. In the 14 years that he held this position he assisted in the organization and financing of 20 cooperative packing associations, as affiliates of the Florida Citrus Exchange, and brought 70 percent of the fruit produced in Polk County into the Exchange.

In 1916 Mr. Walker organized the Growers Loan and Guaranty Company, to finance Exchange growers and to finance Exchange packing facilities. He served as President of this company, which now has a capital and surplus of more than \$1,500,000, until 1939, and continued to serve on its Board of Directors.

Mr. Walker also organized the first cooperative association in the Florida citrus industry for the purchasing of packing house supplies, and later assisted in the formation of the Exchange Supply Company, as an affiliate of the Florida Citrus Exchange,

serving as a director and as president of that company for more than 20 years.

In 1929 Mr. Walker organized the Avon Florida Citrus Corporation at Avon Park, Florida, which owns and operates more than 3,000 acres of citrus groves and is considered to be the largest single producer of citrus fruits in Florida. He has been its president and majority stockholder since it was organized.

Mr. Walker served as a director of the Florida Citrus Exchange, and as president of three of its affiliates, for more than 20 years, when, in the Spring of 1939, he was elected president and chairman of the board of directors of the Exchange. He continued to serve the State's largest cooperative marketing association in these positions.

In addition to his activities in cooperative packing, marketing, processing, purchasing and financing associations, Mr. Walker has taken a leading part in many other Florida citrus industry activities. He was vice-president of the National Council of Farmer Cooperative, vice-president of the Florida Citrus Producers Trade Association, and former chairman of the Growers Administrative Committee which organization administers the Federal marketing agreement for Florida citrus fruits.

At the time of his death Mr. Walker was president of the Ridge Area Hospital Association, president of the Avon Milling Company which manufactures citrus crates in Avon Park, president of the Southside Park Company which has been furnishing better type homes for the Negro section of Avon Park, a director of the State Chamber of Commerce and a member of their Agriculture Committee, president of Highland Crate Cooperative of Jacksonville and an honorary member of the Avon Park Rotary Club.

#### LIONEL L. LOWRY

Lionel L. Lowry died September 20, 1947, at 53 years of age at his home in Winter Haven, Florida, where he has lived

and worked for nearly all of his 34 years of labors in the citrus industry of Florida. His first work was with Schrader and Co. of Jacksonville, from which position he rose to vice-president and general manager of the Florida division of DiGiorgio Fruit Corp. Under his management this company became the largest single factor in the Florida citrus deal. They pioneered the first commercial juice canning plant in the state at Lucern Park. They developed large acreages of winter truck crops in South Florida. We regret that death terminated an enviable record of commercial achievement.

#### MAJOR W. L. FLOYD

Major W. L. Floyd, assistant dean of the University of Florida College of Agriculture for many years before he retired in 1938, died at his home in Gainesville on the evening of April 29, 1947.

He had lived in Gainesville since 1892, when he first became connected with the East Florida Seminary, predecessor of the University of Florida. While active with the College of Agriculture he headed the department of horticulture and was known and loved by former students and others throughout Florida.

#### BAYLESS W. HAYNES

Born a native of Tennessee and receiving his early education from Webb School at Belt Buckle and from Vanderbilt University.

Bayless W. Haynes achievements are synonymous with that of the larger fertilizer interests of Florida. Beginning as a young man in 1905 he later became president and chairman of the board of Wilson and Toomer Fertilizer Co. In the early days his company assisted the Experimental Division of our Experiment Station in presenting new fertilizer materials to Florida. To his leadership in the fertilizer mixing



field can be traced much of the high quality fruit now grown with commercial mixtures. Pioneered by his company extensive grove acreage at Davenport developed thru his aid and were often used as proving grounds for fertilizers and insecticides. His whole life was devoted to his company and its subsidiaries including the Florida Agricultural Supply Co. of Orlando.

Florida Citrus is indeed a monument to Bayless Haynes.

#### *CHARLES E. ABBOTT*

Charles E. Abbott, 54, professor of horticulture at the University of Florida, died August 14 at his home in Gainesville. He had been on the horticulture staff of the College of Agriculture since 1923.

A native of Gotha, near Orlando, he received elementary school training in Orange County. He received two degrees from the University of Florida, and an advanced degree from Michigan State College, and had done additional graduate work there and at Cornell University.

A member of the Alpha Gamma Rho fraternity, he also held membership in Alpha Zeta, Phi Kappa Phi, Phi Sigma, Kappa

Delta Pi and Thyrsus honorary organizations, the Florida State Horticultural Society and American Society for Horticultural Science.

#### *GEORGE ROY BROCK*

George Roy Brock, 58, for 21 years general manager of the Indian River Sub-Exchange, with headquarters at Cocoa, died October 21. Mr. Brock, a native of Barnard, Kansas, moved to Cocoa in 1925 from Montana. Since that time he had served as general manager of the Indian River Sub-Exchange, a part of the Florida Citrus Exchange.

He was appointed a member of the Florida Citrus Commission by Governor Holland in 1941 for a two-year term. He was reappointed in 1943. Mr. Brock during his residence in Cocoa was a member of the Kiwanis Club, a member of the board of directors of the Greater Cocoa Chamber of Commerce, and was active in other civic matters. He was a veteran of World War I and a member of the Cocoa Post of the American Legion. He was known and liked by hundreds of friends and acquaintances.



APOPKA  
ROBINSONS  
ORLANDO

PROCEEDINGS

*of the*

SIXTY-FIRST ANNUAL  
MEETING

*of the*

Florida State Horticultural  
Society

*Held at*

WEST PALM BEACH, FLORIDA  
OCTOBER 26, 27 and 28

**1948**



*Published by The Society*



# Florida State Horticultural Society

## Officers Elect for 1949

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### PRESIDENT

FRANK STIRLING  
Davie

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*Vice President*  
Bradenton

### KROME MEMORIAL INSTITUTE

S. J. LYNCH  
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### VEGETABLE SECTION

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RALPH H. THOMPSON, Winter Haven  
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DR. F. S. JAMISON, Gainesville

---

### EXECUTIVE COMMITTEE

DR. J. R. BECKENBACH, Bradenton	FRANK L. HOLLAND, Winter Haven
H. A. THULBERRY, Lake Wales	R. S. EDSALL, Wabasso
J. K. SPARKMAN, Tampa	



# CONSTITUTION

Article 1. This organization shall be known as the Florida State Horticultural Society, and its object shall be the advancement of Horticulture.

Article 2. Any person or firm may become an annual member of the Society by subscribing to the Constitution and paying three dollars. Any person or firm may become a perennial member of the Society by subscribing to the Constitution and paying the annual dues for five or more years in advance. Any person or firm may become an annual sustaining member of the Society by subscribing to the Constitution and paying ten dollars. Any person may become a life member of the Society by subscribing to the Constitution and paying fifty dollars. Any person or firm may become a patron of the Society by subscribing to the Constitution and paying one hundred dollars.

Article 3. Its officers shall consist of a President, one Vice President for each section, Secretary-Treasurer, Assistant Secretaries, and Executive Committee of five, who shall be elected by ballot at each annual meeting. These officers shall take their positions immediately following their election. The duties of the Assistant Secretaries shall be outlined and supervised by the Executive Committee.

Article 4. The regular annual meeting of this Society shall be held on the second Tuesday in April, except when ordered by the Executive Committee.

Article 5. The duties of the President, Vice Presidents, Secretary and Treasurer shall be such as usually devolve on these officers. The President, Secretary and Treasurer shall be ex-officio members of the Executive Committee.

Article 6. The Executive Committee shall have authority to act for the Society between annual meetings.

Article 7. The Constitution may be amended by a vote of two-thirds of the members present.

Article 8. A section of the annual program of the Society shall be devoted to the discussion of sub-tropical fruits, exclusive of the

commonly grown varieties of citrus fruits. This section shall be known as the KROME MEMORIAL INSTITUTE. It shall be presided over by a fourth vice president who shall be elected by ballot at each annual meeting of the members in attendance at the Institute. The fourth vice president shall be an ex-officio member of the Executive Committee.

Article 9. The Executive Committee may, at its discretion and on the basis of merit, nominate not to exceed five persons in any one year, for Honorary Membership in the Society. Honorary members shall enjoy all privileges of the Society.

Article 10. A section of the annual program of the Society shall be devoted to the discussion of vegetables and other truck crops. This section shall be known as the VEGETABLE SECTION OF THE FLORIDA STATE HORTICULTURAL SOCIETY. It shall be presided over by a Vice President, who shall be elected at each annual meeting of the Society by the members in attendance at the Session. The Vice President shall be an ex-officio member of the Executive Committee.

Article 11. A section of the annual program of the Society shall be devoted to the discussion of ornamentals. This section shall be known as the ORNAMENTAL SECTION OF THE FLORIDA STATE HORTICULTURAL SOCIETY. It shall be presided over by a Vice President, who shall be elected at each annual meeting of the Society by the members in attendance at the Session. The Vice President shall be an ex-officio member of the Executive Committee.

Article 12. A section of the annual program of the Society shall be devoted to the discussion of processing. This section shall be known as the PROCESSING SECTION OF THE FLORIDA STATE HORTICULTURAL SOCIETY. It shall be presided over by a Vice President, who shall be elected at each annual meeting of the Society by the members in attendance at the Session. The Vice President shall be an ex-officio member of the Executive Committee.



## **BY - L A W S**

1. The Society year shall be coextensive with the calendar year, and the annual dues of members shall be three dollars.

2. All bills authorized by the Society or its Executive Committee, for its legitimate expenses, shall be paid by the Secretary's draft on the Treasurer, O.K'd by the President.

3. The meetings of the Society shall be devoted only to Horticultural topics, from scientific and practical standpoints, and the presiding officer shall rule out of order all motions, resolutions and discussions tending to commit the Society to partisan politics or mercantile ventures.

4. All patron and life membership dues and all donations, unless otherwise specified by donor, shall be invested by the Treasurer in United States Government bonds. The earnings from these bonds shall be left as accrued values or reinvested in United States Government bonds of a guaranteed periodical value unless it is ordered by the Executive Committee or the Society that such earnings can be made available for operating expense. Receipts from perennial membership dues shall be placed on deposit at interest by the Treasurer. Only three dollars (\$3.00) from each perennial membership fee shall be available during any calendar year for payment of operating expenses of the Society.

# LIST OF MEMBERS



## HONORARY MEMBERS

Fairchild, Dr. David, Coconut Grove	Hume, Dr. H. Harold, Gainesville
Haden, Mrs. Florence P., Coconut Grove	Lipsey, L. W., Blanton
Hastings, H. C., Atlanta, Ga.	Mayo, Nathan, Tallahassee
Henricksen, H. C., Eustis	Robinson, T. Ralph, Terra Ceia
Holland, Spessard L., Bartow	Swingle, Dr. W. T., Washington, D. C.

## PATRON MEMBERS

American Agricultural Chemical Co., Pierce	Gulf Fertilizer Co., Tampa
American Fruit Growers, Inc., Maitland	Hastings, H. G. Co., Atlanta, Ga.
Angebilt Hotel, Orlando	Hillsboro Hotel, Tampa
Armour Fertilizer Works, Jacksonville	Klemm, A. M. & Son, Winter Haven
Buckeye Nurseries	Lake Garfield Nurseries, Bartow
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Coral Reef Nurseries Co., Homestead	Mills The Florist, Jacksonville
Deerfield Groves, Wabasso	Nocatee Fruit Co., Nocatee
Deering, Chas.	Oklawaha Nurseries Co., Inc., Lake Jem
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Exotic Gardens, Miami	Stead, Lindsay, P. O. Box 809, Ft. Pierce
Florida Citrus Exchange, Tampa	Thomas Advertising Service
Florida East Coast Hotel Co., St. Augustine	U. S. Phosphoric Products, Tennessee Corporation, 61 N. Broadway New York, N. Y.
Florida Grower Publishing Co., Tampa	Van Fleet Co., Winter Haven
The Fruitlands Co., Lake Alfred	Wilson & Toomer Fertilizer Co., Jacksonville
Gardner, F. C., Lake Alfred	
Glen St. Mary Nurseries Co., Glen St. Mary	

All addresses are in Florida unless otherwise shown.

## LIFE MEMBERS

- Agricultural Exp. Station, Puerto Rico  
Albertson Public Library, Orlando  
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Alderman, A. D., Bartow  
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Chicago, Ill.
- Barber, C. F., Macclenny  
Bartlum, W. Leonard, Fla. Agr. Supply  
Co., Orlando  
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Bouis, Clarence G., Box 6, Ft. Meade  
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Britt, John F., Ft. Pierce  
Brown, A. C., Gainesville  
Bullard, Henry F., c/o Bullard & Sprott,  
Lake Wales
- Carnegie, Mrs. T. M., Fernandina  
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Chidester, D. D., 446 Painter Ave.,  
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Crutchfield & Woolfolk, Pa. Produce  
Bldg., Pittsburgh, Pa.
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- Ellsworth, Wilma J. (Miss), Rt. No. 1,  
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- Lassen, H. C., Garden Spring Terrace,  
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Rico

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Wilson & Toomer Fertilizer Co., Box  
4459, Jacksonville

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## FLORIDA STATE HORTICULTURAL SOCIETY

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1948

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Fla.  
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Division, Middleport, New York  
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Fla.  
Dye, John B., Jr., Box 821, Ft.  
Lauderdale, Fla.  
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Florida Dolomite Co., Pembroke, Fla.  
Florida Growers Magazine, Tampa, Fla.  
Florida National Bank, Lakeland, Fla.  
Florida State Library, W. T. Cash,  
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- Gardner, Mrs. F. C., Lake Alfred, Fla.  
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Groebe, R. H., Box 1429, Cocoa, Fla.  
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Groff, Geo. Weidman, Box 11, Laurel, Fla.  
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# PROCEEDINGS OF THE FLORIDA STATE HORTICULTURAL SOCIETY, 1948

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*Text of Addresses*  
*Delivered at*  
*61st Annual Meeting*  
*Florida State*  
*Horticultural Society*





## PRESIDENT'S MESSAGE

W. F. WARD  
Avon Park

The citrus growers of Florida breathed a sigh of relief on the afternoon of October 5th when the second hurricane to hit Florida in a period of three weeks passed out to sea without doing serious damage to the citrus fruit crop and groves of the State. Neither of the two hurricanes hit the main citrus growing sections of the State and the loss to the industry as a whole was negligible. The lower East Coast growers did not fare so well and 75 percent of the avocado crop on the trees was blown off by the hurricane of September 21st and 22nd. Most of the remaining crop was blown off during the last storm. The older and taller trees suffered considerable breakage of limbs but the younger trees were not seriously damaged by the winds. Torrential rains which fell during each storm have given the growers in the Miami and Homestead areas a problem which may cause greater damage than the winds. Persian lime groves suffered considerable damage and loss of most of the remaining fruit crop. About one-half of the avocado crop and two-thirds of the lime crop had been harvested in the Homestead area prior to the first hurricane. The avocado and lime growers in the Ridge area had small losses.

Vegetable growers suffered heavy losses in the lower East Coast and the Lake Okeechobee sections. The damage to the sugar cane crop is still undetermined. Taken as a whole, weather conditions during the last 12 months have been rather favorable. Some localities

had slight damage from the cold on the night of January 16th. Other sections suffered from drought during May and early June but the majority of the State had good rains scattered well throughout the year and less irrigating was done than normal. All of the citrus area of Florida excepting a small area of the West Coast has had more than average rainfall which has been quite beneficial to citrus groves and resulted in the best cover crops grown in recent years.

The 1947-48 marketing season which ended in August was generally unsatisfactory and considerable grapefruit was left on the trees. The outlook for a profitable season in 1948-49 is not very bright. The need of one large marketing agency for the sale of citrus crops becomes more apparent as time goes on and our fruit crops increase in volume. Just when 80 percent or more of the growers will come to an agreement and work together is the \$64.00 question.

Florida citrus groves are now producing 100 million boxes of fruit a year and before many years our production will doubtless reach 150 million boxes. The canning industry is using a larger volume of fruit each year. During the 1947-48 season just closed, about 30 million boxes of oranges and 20 million boxes of grapefruit were used in making canned juices, concentrate, frozen concentrate and sections. While the amount of fruit used in the future for canning will doubtless increase, it will undoubtedly reduce the consumption of fresh fruit so that the successful marketing of our citrus crop will remain our greatest problem for some time to come.

Considerable progress has been made by the State and the Federal experiment stations and laboratories in production practices, disease and insect control, treatment of fruit for shipping and water control measures. Additional funds are needed by all of the stations for more buildings, equipment and better paid personnel to take up new problems confronting the industry. Some of the more pressing problems are studies of soils and soil moisture as affecting tree growth, quality and quantity of fruit produced, water conservation and control, irrigation practices, improvement in packing house methods and packing of fruit and development of new types or improved forms of agricultural machinery. We must admit that we have been woefully backward in agricultural engineering research work. Decided improvements are necessary in our present machinery and equipment and new types are desirable for better cultural practices, spraying and dusting.

The rapid growth and expansion of the Vegetable Section of our Society has been extremely gratifying. The splendid programs are attracting increasingly large numbers to that section. Their representatives state that market conditions on vegetables generally were good during the year. The exceptions were celery and lima beans with potatoes and beans not doing too well at times. High water in the Everglades and lower East Coast areas last year delayed planting of both vegetables and bulbs which resulted in very heavy production at certain times and a consequent drop in prices. The distribution of products was not as uniform as normal. Excessive water in the Lake Okeechobee and lower East Coast sections again this year will delay plantings and may cause similar

market conditions to last year. Prices drop quickly when "gluts" occur.

Vegetable plantings in the winter producing areas, extending roughly from Vero Beach to Homestead, increased by more than 20,000 acres during the last 10 years. This rate of increase of winter vegetables is not expected to continue.

The U.S. Department of Agriculture has developed and released a new variety of tomato, named the Southland, that is "field immune" to the Fusarium Wilt and the State Vegetable Crops Laboratory at Bradenton has developed two new varieties, the Manasota and the Manahill that are also immune. The Southland and the Manahill are both resistant to Early Blight and the Manahill is also resistant to the Gray Spot disease of the leaves. By next year it is hoped that seed houses will have fair stocks of seed of all three of these varieties.

No new diseases of vegetables appeared during the year but "Black Heart" in celery was especially severe in the Sarasota area. The Bradenton laboratory has definitely proven that all leaf spot diseases can be kept under reasonable control by spraying with dithane-zinc sulfate-lime formula on a 5-day schedule.

The cut flower industry in south Florida has expanded very rapidly in the last 5 years. Last year approximately 1,650 acres were planted on the lower West Coast and about 1,000 acres planted on the lower East Coast. Market conditions were very good during the fall and early winter season, but from January 15th to May 1st the market was depressed.

The prices of gladiolus were down for the second consecutive year. Plantings of "glads" had expanded so rapidly

during the war period that overproduction finally occurred and "gluts" developed. Some disease in shipments also hurt prices.

The *Curvularia* disease of gladiolus (new to Florida last year) caused losses on both corms and cut flower stock. A breeding program has been started at Bradenton to develop a disease resistant strain of the Picardy which is the principal gladiolus variety.

The amount of *Narcissus* planted has gradually declined for several years until there are only four or five growers having sizable acreage.

Easter lily plantings increased at a tremendous rate during the war years but by 1946, the virus disease known as fleck had become so severe and widespread that it put many growers out of business. No satisfactory method of controlling this disease under Florida conditions has been developed to date. Buyers will not buy bulbs for forcing from fleck-infected fields.

The growing of *Amaryllis* has developed into quite an industry in Florida and market prices have been reasonably good.

The Ornamental Section of the Society was formed last year and there was a reasonably good attendance at the meeting even though there was little advance publicity. We shall be very happy to see this new section grow and prosper.

The Krome Memorial Institute reports that interest in tropical and subtropical fruits, other than citrus, had increased steadily during the last year. The acreage of avocados, guavas and mangos was substantially increased despite hur-

ricanes and floods. New varieties of guava have been distributed to nurseries and individuals and a breeding project to improve the guava was started by the Subtropical Experiment Station at Homestead. Air-layering, by using the technique employed on the lychee, described by Wm. R. Grove in the 1947 Proceedings, has proved a rapid and satisfactory method of propagating the common guava.

A method of grafting small seedling lychees was developed by the Florida Station which will permit rootstock studies with this excellent fruit which is becoming established as a new commercial fruit for Florida.

A variety collection of sapodillas has been established at the Subtropical Experiment Station and includes selections of importations from Nassau, budded to seedling stock.

Budwood of avocados from Central America was obtained from Dr. Wilson Popenoe and successfully grafted to seedling stocks at the Subtropical Experiment Station at Homestead.

There have been 177 new species of fruits and ornamentals imported during the year and these are being grown at the Subtropical Station. New diseases of the avocado and papaya are being studied there.

Considered as a whole, the horticultural interests of the State have had a fairly successful year. Progress will be made in production methods, disease and insect pest control and it is hoped reasonable success will be attained in marketing. This is the greatest problem facing the citrus growers of Florida today.



## FLORIDA CITRUS MUTUAL

J. C. MORTON

The Florida Bankers Association in their report which followed their intensive and constructive study of the citrus industry called it "a loose, sprawling, rapidly expanding, unorganized, unhappy, and sick industry." This is a very descriptive and true statement.

That the industry is still expanding is easily proved by consideration of the production figures for the last 10 years. The amount of Florida citrus fruit utilized and marketed in the season of 1937-38 was 40 million boxes and in the season of 1947-48, 10 years later, 91 million boxes. So, our production has expanded more rapidly than has our program for disposing of it profitably. The bankers were decidedly right when they called it a sick industry, because it is sick. Last season, and I quote Frank H. Scruggs, Market News Specialist of the Florida State Marketing Bureau, in the Annual Report released October 11, 1948: All oranges shipped as fresh fruit netted on the average to the growers of the State, 28 cents per box above cost of production out of which still had to be taken interest on investment, depreciation and taxes. For grapefruit, the figure was 36 cents per box and for tangerines, 40 cents per box. On fruit that was used for canning and processing in Florida, the grower netted for oranges, 3 cents per box as against the 28 cents in the fresh fruit market. On grapefruit, minus 19 cents per box, against the 36 cents in the fresh fruit market and on tangerines going to canneries, minus 60 cents per box against the 40 cents on those that were shipped fresh. All of these figures are after cost of production has been

paid, but do not include deductions for interest, depreciation or taxes. For all fruit marketed, both fresh and in cans, we averaged for oranges 15 cents per box above cost of production, for grapefruit minus one cent a box, and for tangerines 20 cents. The crop as a whole, including all varieties marketed fresh and in cans, netted the grower an average 10 cents per box above cost of production with no deduction taken for taxes, depreciation on equipment or interest on investment. So, it can be very rightfully said that the industry is definitely sick. These are the figures for last year. Already we have begun another marketing season, and what are our prospects?

Drew Pearson, our noted Sunday evening news commentator, in his predictions of things to come, claims to be around 80 percent accurate. This very remarkable record has been topped by the Florida Bankers Association, because the bankers, following the hearings, made this very definite prediction which is proving 100 percent accurate and I quote:

"At the moment, there is little hope for even a cost-of-production price for the maturing Florida crop. The price situation looks dark, if this crop is to be marketed under the same procedure as the last two crops."

That this prediction is coming true is clearly indicated by a front page headline in the Orlando Sunday morning *Sentinel-Star* of only 5 days ago. The headline read "ORANGE PRICES DRAG BOTTOM" and reported that auctions had last week reached the low-

est point of the new season. That the week's average was \$2.96 for interior oranges on sales of more than 100,000 boxes through the terminals. That on Friday, the last sales day of the week, prices sank to \$2.72 per box. In the same double column in the same newspaper was another article headed "WIDOW PLEADS FOR HELP IN CITRUS CRISIS."

We have started another marketing season under the same procedure as the last two crops and the bankers' prediction is coming true. Everybody is asking, what is the matter with our industry, and some folks say it is overproduction. However, I am not yet willing to admit this because there never has been a test of our ability to market our crop profitably through orderly marketing procedures. The major part of last season's crop has been consumed and utilized, which is evidence that production is not beyond the capacity of the market. Our difficulty is that it has been marketed in such a cutthroat, disorganized manner that there has been neither orderly distribution, as to time or place, and in consequence, growers have much less money than could have been had, had the marketing been organized and business-like. A short time ago, I sat across the desk from the president of the New York Auction and he made this very definite statement: "If there was orderly marketing of Florida citrus crop through organization, the New York Auction would not only get more money for the fruit but would sell more fruit at the higher price, because of the confidence the trade would have in our marketing procedures." This again leads me to quote the Bankers' Report where they say:

"The brokers and dealers in the market have no confi-

dence in the stability of Florida citrus prices or the system under which our fruit is sold, because there is no coordination or control of movement of fruit to markets. As a result, many markets are frequently and almost regularly overloaded with disastrous results to the price structure."

The major needs of the Florida citrus industry may be very briefly stated:

1. control of the quality of the fruit shipped, both fresh and canned.
- 2 control of the fruit to market, both fresh and canned.

With these adequately and effectively put into operation, many of our current citrus problems would be solved, and the only way that these can be developed and put into practical service is through organization and that means organization of citrus growers under the protection of the Capper-Volstead Act.

In 1945-46 for the 86 million boxes sold, the growers received 236 million dollars. In 1946-47, the production was 83 million boxes for which we received 146 million dollars, and in 1947-48, we marketed 91 million boxes for which we received 114 million dollars. So, in the 1946-47 season, we received 90 million dollars less for our fruit than we did during the season of 1945-46, and in 1947-48 we received 122 million dollars less than we did for the crop of 1945-46. That means for the past two seasons there was a total of 212 million dollars lost to the citrus industry of Florida and that money rightfully belonged in the pockets of the growers. Packers and processors, crate manufacturers, pickers

and haulers, transportation companies, all were paid and the grower had what was left. We will continue to take these losses until we unite in a program to avert them. The only person who can correct this situation is the grower. Until growers join together in an organization to insist on proper business practices in our industry, these losses will occur regularly, sometimes being less, sometimes being more, depending on marketing conditions, but always securing less than we could, if our marketing procedures were organized and stable.

Some proposals are being made for additional State legislation, applicable to the citrus industry, and with many of these we could have no quarrel. However, there are three handicaps to this idea. First, State legislation is limited in its application and legal power; second, there is no guarantee of what a State legislature will do, and three, the legislature meets too late in the spring to be of any immediate help in the present plight. Unless growers unite and do it speedily, they may lose 10 million dollars per month in the coming marketing season. This means not only loss to citrus growers but a tremendous loss to every business in citrus Florida.

Three days ago, I ate lunch with a group of businessmen, everyone of whom was complaining about the effect of the present low prices of citrus on his particular business. The group included the owner of a large book and office supply house, a barber, an automobile salesman, a motion picture theater executive and an insurance man, all were complaining about the slump in business. They very definitely blamed the citrus industry. The whole economy of the State is affected and this can be readily understood. We lost one hun-

dred million dollars a year during the last 2 years. Economists tell us that this money which comes into Florida in exchange for our fruit, turns over from five to seven times in those citrus communities. Multiply this one hundred million by five and you find that in each of the last 2 years, there has been one-half billion dollars less business transacted in citrus Florida.

Let us view it from another angle that brings it sharply into focus. Our marketing season averages 8 months. For easy figuring take 25 working days per month and eight times 25 gives us 200 working days in which we lose 100 million dollars. Divide 100 million dollars by 200 and the loss is one-half million dollars per day to the citrus growers of the State.

What are we going to do about it? There is one answer and one only, and that is, that citrus growers must organize, join together, and use the protection given them by the Capper-Volstead Act. This will enable them to do all the things good judgment finds necessary to bring back prosperity. Why stand on the street corner berating the citrus Commission, the shipper, the canner, the auction market, the dealer and the distributor. This is futile and worthless expenditure of time and energy. All we have to do is organize as a grower organization and take our rightful control of the situation.

How can this be done? It can be done through Florida Citrus Mutual, a grower-owned and grower-controlled organization which will be put into operation just as soon as 75 percent of the growers of the State sign grower contracts. This being done, the growers will immediately elect their own board of directors who will use such of the powers granted

who seem to have built a reputation on profound pronouncements on abstruse matters that none of us laymen can understand.

Seriously, the text I am going to take is from a report made early in 1929 by the National Committee on Social Trends. This was not a New Deal agency but a committee of research men selected by President Herbert Hoover from many fields to analyze the Nation and its social-economic health. The conclusions were reported some months before the Black Friday that closed the stock markets of this country and led to the worst depression we have ever experienced. If its findings and recommendations had been taken more seriously, we would certainly be in better condition today.

In that report the statement was made that: "Progress in different lines has been unequal. Our capacity to produce goods changes faster than our capacity to consume." Elsewhere the committee said: "There are no physical obstacles to full employment of national resources. The chief dangers to orderly preparation and execution of plans which would provide an atmosphere in which the individual might prosper in a capitalistic economy are to be found in the human mind—in the habits, the suspicions, the lack of confidence in the future, and the unwillingness to thoughtfully consider what the future may hold before it is too late, that are exhibited by many Americans."

The same may be said of the Florida citrus and vegetable industries. There is no basic reason why each of them could not—without sacrificing the individuality or initiative of the grower—develop and execute industry-sponsored programs under which the efficient

grower and shipper could enjoy the maximum of prosperity, weather and national economic conditions permitting. That few of these programs have been allowed to effectively mature can be attributed less to lack of quality in the proposals than to the unwillingness of the grower to accept them before it is too late.

I believe I can make the unqualified statement that the key to the prosperity of the Florida vegetable industry lies within itself, contingent only on the maintenance of a relatively high level economy in the Nation. Research men may develop new and better products and methods, effective preventatives, and other techniques which will permit the grower to produce better beans, celery, and tomatoes—but that is not enough. The grower must not only accept these new methods, but he must also be willing to adapt his entire operating procedure so that these new techniques will dovetail into an orderly production and marketing program.

This, I say, can be done without sacrificing the individual freedom for which the vegetable grower strives. His unwillingness to accept governmental domination or subsidy is laudable, but it provides no affirmative answers. He must be willing to analyze his problems, learn where they parallel those of other growers, and cooperate with them in their ultimate solution, to assure the maximum opportunity for individual prosperity.

Rather than eliminating the incentive of competition which is inherent in the capitalistic system, it actually provides a greater degree of freedom for the grower to use ingenuity and intelligently applied effort in the attainment of his economic goals. In a static or regressive atmos-

banker very forcibly stated: "It will be canned in the morning and marketed in the afternoon, and everybody can readily predict the consequence of that procedure."

If it were possible for me to reach the car of every citrus grower in Florida, I would ask him: "Are you going to do something about it, or are you going to sit complacently by and wait for the crash that is bound to come?" Most of us have touched bottom in each of the past two seasons and unless rescue comes quickly, we are about to go down for the third time which may be the last for a great many.

Organization is the only answer and Florida Citrus Mutual is the only organization available. It has all the needed legal and chartered powers. The grower members will elect their own board of directors, 21 in number, two from each of the seven citrus commission districts and seven nominated by these fourteen, elected at the State-wide annual meeting. But somebody says, this is a grower board of directors and the problem is a marketing problem, what do growers, generally, know about citrus marketing? The answer is that this has been taken care of, inasmuch as, there

is provided in Mutual an executive committee, each of whom must be representative of a handler, who has entered into a handler's contract with the association, and handler means any person, firm, association, corporation, or other business unit engaged in any way or manner in handling, buying, packing, processing, canning, shipping, and/or marketing of citrus fruits or products thereof for the account of the producer thereof, or for his or its own account, or both. The members of the executive committee shall be nominated by handlers who have entered into handler's contracts with the association, but shall be approved and elected by the board of directors of this association.

In this way, the Mutual Board of Directors is guaranteed the counsel of men trained, experienced, and skilled in marketing procedures, to direct the marketing plans and policies. Grower contracts are for 10 years with the privilege of withdrawal during June of any one year, and no grower need hesitate whatsoever in signing a Mutual contract because it is purely and simply a grower organization whose only purpose is to endeavor to bring back and maintain prosperity among citrus growers.

## NATIONAL COMMITTEE ON SOCIAL TRENDS

LAMONTE CRAW, MANAGER

*Florida Fruit & Vegetable Association*  
Orlando

Mr. Chairman, ladies and gentlemen, in looking over today's program I find that everyone has a subject assigned—some with undecipherable names—with the exception of Frank Holland and myself. Possibly the fact that we are lay-

man and therefore incapable of intelligently discussing these highly technical matters, is the reason for the omission. On the other hand, it might be that Frank and I failed to decide what we were going to talk about until today.

Like the preacher, I am going to take a text and then talk about everything else. In that respect I will be following the lead of some of our eminent scientists

in the charter as in their judgment may be needed to improve conditions. This requires no immediate need of legislation. If growers would speedily take advantage of it, it could be put into operation at a very early date, in time to practically and very effectively aid in the current season.

But, let me issue this warning, time is fleeting. The days go rapidly by. Many growers, shippers and canners have already signed, but not enough growers to yet put the plan into operation. However, this could be done by the middle of November if the growers so desire it. Following the 75 percent sign-up, less than one month would be required for growers to elect their own board of directors. Meanwhile, plans and procedures can be prepared for the board's consideration so that they may put them into effect as speedily as possible and certainly not later than the first of January, confidence could be restored to Florida State marketing that would almost overnight effect a helpful stabilization in prices.

Let me again quote the report of the Florida Bankers Association:

"We favor the principles of the Florida Citrus Mutual and we recommend, we urge, the growers of Florida to consider the contracts and put it into operation at the earliest possible moment. We recommend it on the further premise that the industry has everything to gain and absolutely nothing to lose in trying it."

During the coming season, not less than 60 million boxes of Florida citrus fruit will be available for canning and

processing. Sixty million cases of citrus products in cans to be marketed over a 12-month period means five million cases per month, but this is canned in about a 6-month period or ten million cases canned per month. We will can five million cases more per month than should be marketed during the canning months. This means that about thirty million cases will have to be financed in warehouses for distribution during the months that no canning is being done. It takes money to can this fruit and warehouse it. One prominent banker of the State estimates the amount needed in excess of 100 million dollars. This money is readily available from Florida bankers, if and when the industry becomes organized. Listen again to the bankers:

"If a Statewide organization is not formed, if standards are not raised and not enforced, then we suggest that financing warehouse receipts, even at one-half of the current market will carry unusual risk hazards. If Mutual is formed, and the canners are included, and the movement to market of both fresh fruit and processed is controlled, so as to furnish only an orderly supply; if quality standards are adopted and enforced; then we believe Florida banks will find the financing of canner's warehouse inventories a perfectly safe and good bankable risk."

Many of the canners in Florida today are stating that they will can this year only on consignment basis, and as one

phere, such as exists when growers fail to unite their efforts to improve production and marketing conditions, the grower lacks the capital and opportunity to improve his methods, reduce his unit costs, and enjoy the fruits of his labors. He is so busy doing expedient things in order to stay in business that he has no time for improving the efficiency of his operations, or the quality of his products. He may think he is asserting his independence but actually he is exhausting his resources in unavailing efforts to fight his economic battles alone. This so-called "independence" can lead either to bankruptcy, or to the grower being "dictated to" by the banker, the fertilizer seller, or the commission man who finances him.

The efficient, progressive producer first seeks to develop a favorable atmosphere, and then to profit by the competitive opportunities it affords him.

The successful development of a well-rounded economy for the Florida vegetable industry is in part dependent on the continued development of new production methods, and their adoption, but it is not enough to produce a perfect stalk of celery—it must be sold at a price that will return the grower his cost plus a profit increment, otherwise the efforts of both the researcher and the grower have been wasted.

You might well ask why I present this situation to a group primarily interested in the technological phases of vegetable production and handling. It is properly a field for the economist, and for trade associations such as ours which have the heavy responsibility of trying to sell the grower on the need for unity of effort before it is too late. However, it is axiomatic that there must be continuous progress in all phases of agricultural de-

velopment, from seed to ultimate consumption, if the grower is to continue to serve the needs of the Nation at a price the consumer can pay.

Research and extension men have a big stake in the solution of the economic problems of the grower, and it behooves them to aid in the dissemination of basic economic truths. If the farmer does not progress economically, the desire for technological progress diminishes, and the funds for research may dry up. Even the most elementary college courses in economics provide the trained researcher with knowledge of these facts long before their impact is felt by the grower, who learns of them only by sad experience.

Possibly the researcher feels this is not his field, and that he has neither the right nor the responsibility to give the grower the benefit of his knowledge of basic economics. I cannot concur in that thesis, for it is of little avail if exhaustive research develops a new variety, or a new way of coping with diseases, if the grower cannot profitably market the resultant product.

I believe the research and extension men who come in daily or occasional contact with growers have a responsibility to point out to them that there are no panaceas—that the creation of conditions which permit producing a large crop of beautiful beans or celery or tomatoes is not enough. There must be recognition and acceptance of basic economic laws by the grower, and a successful adaptation of those principles to the solution of his peculiar problems before the job of the researcher is completed.

I do not ask that the scientifically trained men who comprise the nucleus of this Society go out and preach economic reforms to the grower and shipper

—that's our job. But, I do think that you could render a great service to those whom you serve if you will pass on to the farmers with whom you discuss physical problems, your unbiased observations as to the applicability of economic laws to their specific problems. You don't tell him what he must do—you do advise him on what the economists have

taught you about the fundamentals of his problem.

As one of those who feel keenly the constantly growing need for research in all fields, I ask, in closing, that each of you keep this thought in mind as you go about your work—"There's no use to produce it if you can't sell it." I thank you.





# CITRUS SECTION



# THE TRISTEZA DISEASE OF CITRUS IN ARGENTINA

A. F. CAMP

*Vice-Director in Charge  
Citrus Experiment Station*

Lake Alfred

The tristeza disease of citrus, known in Spanish countries as "podredumbre de las racaillas," appeared in Argentina about 1928 but was not recognized as a disease until about 1931 or 1932. Just how this disease was brought into Argentina is unknown, but it is now believed to have been brought in with nursery stock from Australia to which area the disease probably had been brought from South Africa. Importations of citrus nursery stock and budwood into Argentina had been heavy and from all parts of the world including Florida, California, South Africa, Australia, and many other places. It seems quite logical in light of what we know now that it was imported from either Australia or South Africa in nursery stock budded on rough lemon and which was infected but did not show evidence of the disease. Since we know today that orange or grapefruit trees can carry the disease regardless of stock, this importation into Argentina from areas that supplied trees on other rootstocks would not be surprising.

The area into which it was brought in Argentina is an old citrus area lying in northeastern Argentina and comprising the States of Entre Rios, Corrientes, and the territory of Misiones plus a small area in the state of Santa Fe lying to the west of the Parana River which forms the western boundary of the area known in Argentina as the Litoral. The location

of the original infection was near Bella Vista in the province of Corrientes and the disease radiated out from this center for several years before being recognized as anything more than a reaction to bad soil conditions. It spread rapidly from this district throughout the state of Corrientes and some time in the mid 30's appeared in the neighborhood of Pindapoy in southern Misiones and caused a heavy loss of trees in large properties located in that district. The spread to the south into the state of Entre Rios seems to have been somewhat slower than the spread to the east and north, but it presumably appeared in a grove in the Concordia district in central Entre Rios about 1937 and spread from that point to other groves so that by 1942, when the writer was in this district, it had infected most of the groves in central Entre Rios. The disease is generally believed to have been brought to the Concordia district by a nurseryman who brought infected buds from seedling trees in Corrientes. The progress of the disease in the Concordia area very rapidly infected the oranges on sour stock and they were largely out of production by 1946 but mandarins on sour stock were not greatly affected up to that time and many growers believed them to be immune. In 1947 and 1948, however, mandarins on sour orange went out with great rapidity and largely wiped out what had been a large and profitable business in this area. Only scattered and isolated groves in southern Entre Rios had been left unaffected by 1948.

There is another and newer citrus area lying at the foot of the Andes in north-

western Argentina with its southern limits south of Tucuman and the northern around Oran and Tabacal and extending about three hundred air miles in length though very scattered. This area uses almost exclusively sour orange rootstock but did not become infected until much later than the older area. Apparently the infection started at only one point since, in making a detailed survey of the area in 1945, the writer only found trees that had the characteristics of the disease near the town of Chicoana in the province of Salta. The trees on sour orange stock in this district were dying while seedling sour orange trees, seedling sweet orange trees and a few lemons budded on sour orange appeared to be healthy. By 1947 all of the orange trees on sour orange in the district around Chicoana had died and trees were beginning to die in adjacent citrus areas. The disease progressed very rapidly and a survey made in 1948 showed that extensive grove holdings in the vicinity of Chicoana, Betania, Campo Santo, Guemes, and Perico del Carman had been wiped out though these districts were scattered and rather widely separated from each other in some instances by non-citrus areas. It was not possible to definitely determine whether the disease was north of this area at that time though there were some very suspicious looking trees in the vicinity of Santa Rosa very far to the north of this area. Since plantings in this northern area are widely scattered, frequently with some 25 to 50 miles of woodland separating them, its spread is going to be very interesting because the jumps it will have to make are somewhat comparable to the jumps the disease might have to make here between the central district and the East or West

Coast. There are two large holdings, one of about 400 acres and one of 660 acres, all on sour orange which now have infected groves within 25 or 30 miles of them but separated from them by woodland. The progress of the disease here is being watched closely and will be used as a basis for conclusions as to what we might have to do in this state should the disease be found. The loss of trees in this area since 1945 probably runs between a hundred and a hundred and fifty thousand and many small groves have been completely wiped out. The progress of the disease in this territory has been even faster than it was in the old territory and the life of affected trees much shorter as a general rule.

We located the laboratory financed by Florida and Texas at Concordia in the province of Entre Rios, in the old area for a number of reasons. First, the disease was actually in progress in that area and still infecting isolated citrus plantings in the southern part of the state that had not had close enough contact with the rest of the area to already become infected. Also, mandarins on sour orange which are slower to show the disease than oranges were beginning to die in large numbers and offered an opportunity for studying the progress of the disease. Second, there was a great variety of stocks used and these were often mixed in the groves by using different stocks for replanting. This offered an unusual opportunity for stock observation. Combined with this there were many types of citrus grown including oranges, grapefruit and mandarins and on all common stocks. Such material is of extreme importance in carrying on research on a problem of this type. Third, the climate and, in some groves, the soil were very similar to Florida so that we

would not expect to find symptoms disguised through climatic or soil differences. Fourth, there were good laboratory facilities made available by the Argentine government and excellent co-operation was offered. Fifth, Concordia was a relatively large city of forty or fifty thousand population and close to Buenos Aires. Sixth, it was accessible by commercial plane service, to the new area where the disease was just getting started and it would be possible to follow its progress in this area rather readily. Finally, and not least important, there were a great many other diseases and insects present in the groves which are not now present in Florida and which have been giving us some concern. As a result it is possible for any men we send there to work to become thoroughly conversant with a large number of diseases and insects which might at some later date appear in Florida and they would be able to recognize them immediately. This training will give us men better qualified for the carrying on of disease and insect work than we could possibly get in any other way as well as giving us a considerable body of information concerning not only tristeza but other insects and diseases which may in the future cause us trouble.

As a result of the mixture of rootstocks it was possible by survey and detailed grove observation to classify sweet orange, Rough Lemon, *Poncirus trifoliata*, Cleopatra mandarin and probably sweet lime as resistant stocks which could be used for oranges and grapefruit. The sour orange, of course, was known to be highly susceptible but it was also noted that trees on grapefruit root were dying, and this has been confirmed by laboratory and quarantine cage work by DuCharme and grapefruit stock is now

considered a susceptible stock as far as oranges and mandarins are concerned.

This work was made relatively easy by the mixture of rootstocks used and relatively certain because it was possible to observe groves on all of the stocks mentioned as resistant in areas where the disease had wiped out trees on sour orange stock at least six or eight years previously. Sweet lime was found to be affected by another disease and is believed to be immune to the affects of tristeza but not otherwise satisfactory because of the unfavorable experience that they have had with it in Argentina and Palestine.

Similar field observations on actually infected groves in the various areas have shown that oranges on sour orange usually die out with tristeza before mandarins on sour orange or grapefruit on sour orange show the effects of the disease. Thus, in the Concordia district, the sweet oranges were practically all affected and either dead or in the last stages of decline before much of the effects of the disease were noted in mandarins and grapefruit but in the space of about three years in the neighborhood of a million mandarin trees were wiped out in this area. This differential in time of attack has led numerous areas to the belief that both grapefruit and mandarins on sour orange were immune, but observations in all of the districts in Argentina that have already been attacked indicate that this is merely a matter of time rather than a matter of resistance.

In connection with the terms "resistance" and "susceptibility" it should be noted that "resistance" in this case refers to "resistance" to the effects of the disease. It has now become apparent that the disease can infect sweet orange,

grapefruit, mandarin and lime trees on any rootstock, but only those on certain stocks show the decline. Buds of trees on other stocks which have been infected with the virus, however, can transmit the virus to uninfected trees and insects feeding on such infected plants can also transmit the virus. Thus, the terms "susceptible" and "resistant" should be used with care because all varieties of oranges, grapefruit, mandarins, and limes appear to be susceptible to infection by the virus but certain combinations are "resistant" to the bad effects of the infection and certain combinations are "susceptible" to the adverse effects.

While Messrs. DuCharme and King have been carrying on work in Concordia the writer has attempted to keep in touch with the work on quick decline in California to determine to what extent the disease there parallels the tristeza disease in South America. Since there is a great deal of interest in the comparison between these two diseases, the writer will attempt to summarize the comparison as it stands at the present time.

In both cases the disease is due to a virus. In South America the virus is known to be transmitted by buds and in the field by the black citrus aphid; while in California the virus can be transmitted by buds but, while presumably there is an insect vector working in the field up to the present time none has been identified. The incubation period is apparently relatively long in California disease and short in the South American disease. In the case of tristeza infected buds placed in small sour orange seedlings have shown a differential in growth within 120 days when compared with growth of healthy buds placed in sour orange seedlings of the same size. In

California, so far, the use of diseased buds in small sour orange seedlings has not shown any marked growth symptoms even in two years and for identification they use large numbers of buds inserted in the trunks and branches in small nursery trees budded on sour orange stock. The period required for symptoms of the disease to appear being about as much as seven to nine months, this difference is not conclusive since it might be due to the cooler weather in California. The rate of spread is very rapid in the tristeza disease in South America but much slower in quick decline in California. In the latter case the disease is known to have been active since about 1938 and up to the end of this year probably about 150,000 trees will have shown evidences of the disease. In the case of tristeza that many trees have been killed in a single grove district inside of three or four years after the infection has started and usually within an individual grove most of the orange trees on sour orange will be in advanced stages of decline or dead by the end of three years whereas in the case of quick decline a much greater number of years has been required to affect all the trees within a single planting. This may be due to the presence of a much more active vector in South America rather than to a difference between the viruses. Tristeza is known to affect trees of orange, grapefruit, mandarin, and lime on sour orange and grapefruit stocks whereas the work to date in California has shown only sweet orange on sour orange to be affected. This may be due in large measure to the lack of trees on other stocks than sweet and sour within the area where the disease occurs. Later work may change this and show other stocks and other

tops to be affected. In tristeza two types of decline are noted: one, a slow type in which the trees decline slowly over a number of years and frequently do not die but remain weak and unproductive; and a fast type in which the trees decline in a few days and die almost immediately. Somewhat of a parallel exists with Quick Decline, and both types of decline, fast and slow, appear to be present. Lemons budded on sour orange appear to be immune to effects of the disease in both cases.

It will be noted that the diseases line up generally in most details that have been worked out and time may prove them to be the same. At any rate they are very close to each other in character. The slow rate of spread in California may be due to lack of an efficient vector and the cool climate may account for a slower reaction within the tree itself. Until some more details have been worked out for Quick Decline to parallel with the details that have been worked out for tristeza, it is going to be difficult to be certain whether they are exactly the same or different strains of the same type of virus. Since different strains of many viruses exist it would not be surprising if they turned out to be somewhat different.

The slowness with which trees suspected of having Quick Decline can be confirmed or eliminated by the use of budding techniques has disturbed us

somewhat. We had hoped to set up quarantine facilities at Lake Alfred for identifying suspicious cases brought to our attention and DuCharme's work on tristeza indicated that this was highly feasible, but it would appear in the case of Quick Decline that a much longer period would be required and this would tax any ordinary quarantine facilities. This work is being done in the open in California within the quick decline area but we would not like to bring buds from suspicious trees in other areas to Lake Alfred or, in fact, to any other point unless we had a completely isolated location or could do the work in quarantine cages. It is extremely important, however, that we start some sort of a checking program so that we could identify the disease before it became widespread if and when it might be brought into the state.

Work is also in progress in Argentina to determine to what extent the progress of the disease may be delayed once it has started in an area. This is based on our idea that with early identification we might be able to contain the disease within its original area for a number of years and thus give more time for re-planting in other areas. We believe that if all the possible insect vectors are known we could be rigid control programs plus a stoppage of budwood movement delay progress of the disease for a long time.



# A PROGRESS REPORT ON STUDIES OF TRISTEZA DISEASE OF CITRUS IN BRAZIL

1. Behavior of a number of citrus varieties as stocks for sweet orange and grapefruit, and as scions over sour orange rootstock when inoculated with the tristeza virus.<sup>1</sup>

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## INTRODUCTION

A preliminary report of work at Campinas, Brazil, on the tristeza disease of citrus was presented by C. W. Bennett and A. S. Costa and published in the 1947 proceedings of the Florida State Horticultural Society. A more detailed account of their cooperative work is now in manuscript form entitled "Tristeza Disease of Citrus" and will appear in an early issue of the Journal of Agricultural Research. Their work has demonstrated conclusively that the tristeza disease is caused by a virus. They have also shown that the disease is transmissible by budding and they amply confirm the transmissibility of the virus by the black aphid, *Aphis citricidus* Kirk.

The present progress report deals pri-

marily with the behavior of a number of citrus varieties as rootstocks for sweet orange and grapefruit, and as scions over sour orange rootstocks, when inoculated with the tristeza virus. Although some experiments have been carried out under controlled screenhouse conditions, the larger and more extensive tests are being conducted in two nursery plantings in the field. The first planting is called the *Stock Test*, in which sweet orange and grapefruit varieties are being used as scions over as many different varieties of citrus seedling stocks as can be established. The second planting is known as the *Sour Test*, in which each of the citrus varieties, used as stocks in the Stock Test, are used as scions over sour orange rootstocks. This report describes the methods of procedure employed and presents current results from the nursery field tests that are still in progress.

## METHODS OF PROCEDURE

**Seed Sources.** Under the direction of Dr. Frank Gardner and through the citrus stations of the U. S. Department of Agriculture in Florida and Texas and through the cooperation of the Citrus Experiment Station in Riverside, California, seed of 191 citrus varieties and relatives for use in the Stock Test have been sent to Campinas, Brazil. This progress report includes results obtained to date on 79 varieties that have been subjected to the tests.

Seed of an additional 51 varieties for

<sup>1</sup>The writers wish to express appreciation to Dr. Frank Gardner for his helpful guidance and comments especially in relation to the preparation of this manuscript.

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the Stock Test have been obtained in Brazil, largely from the Citrus Experiment Station at Limeira and through the kind cooperation of Dr. Silvio Moreira, Headquarters Department of Horticulture, Instituto Agronomico. Seed of a few odd varieties was secured from the Deodoro Experiment Station, Rio de Janeiro, from plants that had been established from seed sent to Brazil by Dr. W. T. Swingle.

Sour orange seeds used in the *Sour Test* have largely been obtained locally, although some seed of the 15 varieties of sour orange sent from the United States have also been used.

*Screenhouse and Field Plantings.* All seed received have been planted in flats and held under screenhouse conditions. As soon as the plants developed sufficiently, they have been transplanted first to clay pots and subsequently to the Stock Test or the Sour Test nursery plantings. The rows in the first nursery plantings were made one meter apart and four meters in length. Fifteen plants were placed in each row. Whenever possible in the Stock Test, 30 plants or two rows of each variety were established. The first planting in the Stock Test nursery was made in August 1947. The plant growth in general has been very good and budding operations were undertaken in the latter part of January and the first of February 1948.

*Varieties used as scion.* In testing the behavior of citrus varieties as rootstocks for sweet orange and grapefruit, the following general plan was adopted. On the varieties having 30 buddable plants, 5 were budded with buds from seedlings of Barao, a standard Brazilian variety of sweet orange and herein designated as Barao A, 5 with Barao buds taken from orchard trees that were apparently

healthy but known to be definite carriers of the tristeza virus and herein designated as Barao B, 5 with buds from Valencia sweet orange seedlings, 5 with buds of Leonardy grapefruit seedlings and 5 with buds from Duncan grapefruit seedlings. In the case of the Barao A, Valencia, Leonardy, and Duncan seedlings, all plants used as a source of buds were grown from seed under screenhouse conditions and were virus free. The 5 remaining plants of the 30, were not budded but were allowed to develop as unbudded seedlings. In instances where the varieties did not have 30 buddable plants, it was decided to bud as many plants as possible and to follow the order given in the general plan above.

The selection of the Barao sweet orange as a top in the tests was based on previous experience with this variety. It was known to be a variety that was susceptible to tristeza and that showed early recognizable disease symptoms over sour orange rootstocks. Also with this variety both healthy and viruliferous buds were available and could be used on the various rootstocks tested, in order to observe any difference in reaction that might result. The more important economic variety of sweet orange, Bahianinha would have been used in these comparative tests but virus free buds were not available.

It was thought that observable differences in growth of viruliferous and healthy buds on similar rootstocks might occur and might throw some light on the following questions:

1. Would tristeza disease appear any sooner or show any distinctive symptoms over a specific rootstock when the top growth developed from a viruliferous bud as compared with top growth de-

veloped from a healthy bud that was subsequently inoculated?

2. Would any one of the varieties react in such a manner that it might serve as a means of indicating that the buds employed were carriers of the tristeza virus?

3. Would the use of viruliferous buds afford any protection and modify symptom expression in comparison with a possible shock effect and more drastic symptoms following the inoculation of healthy plants?

4. In areas where only virus-infected budwood is available would the citrus growers have to establish a virus free source of buds or could they use infected buds to establish a new orchard over tolerant rootstocks?

The chief reason for selecting Valencia sweet orange as one of the tops in this rootstock test was so that experience could be obtained with a variety of sweet orange that is used in the citrus trade in the United States and at the same time known to be susceptible to the disease in California known as "Quick decline." The tristeza disease and "Quick decline" have many characteristics in common. It is desirable therefore to test comparable plant material so that as information is gained on the "Quick decline" disease on various rootstocks, more detailed comparisons of reactions of both diseases can be made with greater certainty.

Grapefruits were selected as tops in this test because of their economic importance and because experience in Brazil indicated that the reaction of grapefruits to the tristeza disease might possibly be somewhat different from that of the sweet oranges. The use of Leonardy and Duncan grapefruits was due in

large part to the fact that some budwood of both these varieties was available.

The Sour Test nursery planting was started in 1947. The distance of planting was essentially the same as in the variety Stock Test nursery. The plan has been to establish 5 plants of each variety over sour orange rootstocks and to observe their behavior following inoculation with the tristeza virus.

*Sources of Tristeza Virus Inoculum.* Since previous experience had shown that aphids could be used as a rapid means of inoculating citrus plants with the tristeza virus, steps were taken to secure the large number of viruliferous insects necessary to inoculate over 3,000 stock-scion combinations with more than 100 aphids per plant in the Stock and Sour Tests. Through the cooperation of Dr. Moreira, apparently healthy but virus-carrying Barao sweet orange trees in the orchard of the Instituto Agronomico, were cut back so that new growth could develop. Aphids were then brought in and allowed to breed on this new growth for one or two weeks, until the young twigs were practically covered with them. The aphid-infested twigs were then picked off of the Barao carrier plants and placed on the nursery plants to be inoculated. In order to fasten the twigs bearing the aphids on to the plants being inoculated on windy days, paper clips or string were used with success. As soon as the leaves on the detached twigs began to wither, the aphids crawled off on to the plants being inoculated and started to feed. It was noticed that the aphids established themselves best on plants having very young terminal growth, thus increasing the chances of disease transmission to such plants.

When it was found that additional sources of aphids would be needed a

survey was made in the vicinity of Campinas. Three relatively large sources of aphids were found in orchards where tristeza disease was prevalent. Tests of randomized samples of aphids from these sources were made using plants of the susceptible combination of sweet orange on sour orange rootstocks to establish that aphids from these sources were able to transmit the disease. The results showed that the aphids were carriers of the tristeza virus and so a portion of the Stock and Sour Tests were inoculated with aphids from these sources.

Aphid inoculations of all plants were carried out in April and May of 1948 and all plants that showed no positive symptoms of tristeza were reinoculated in July and early August.

#### BEHAVIOR OF VARIOUS STOCK — SCION COMBINATIONS INOCULATED WITH THE TRISTEZA VIRUS

It should be kept in mind that the information in this progress report is based on observations and on specific data obtained from readings taken through August 1948. The tests are still in progress and it can be expected that there will be further additions and possibly some changes as the plant material and disease symptoms develop and as further observations are made and information obtained.

An attempt has been made in Table 1 to organize the citrus varieties by general botanical groups and from the data presented it is evident that there has been some common reactions within these groups.

*Sweet Oranges.* The Barao and Valencia sweet orange tops and the Duncan and Leonardy grapefruit tops have shown no tristeza disease symptoms over

the sweet orange varieties, Pineapple, Valencia, Florida Sweet Seedling, Hamlin, and Parson Brown as rootstocks. All three varieties of sweet orange, Pineapple, Valencia, and Florida Sweet Seedling as well as the three varieties of grapefruit, Leonardy, Foster, and Duncan, when used as scions over sour rootstocks have shown symptoms of tristeza disease.

*Lemons.* In the lemon group there were only 4 varieties included in the current tests and it is of considerable interest to note the distinctly different reactions that have been obtained. The Barao sweet orange tops over Harris lemon as a rootstock, have shown tristeza disease. Similarly both Barao and Valencia sweet orange tops over Lemon P. I. 136469 as a rootstock, have shown tristeza disease. In contrast the various sweet orange and grapefruit tops over Columbia sweet lemon and Sweet Lemon P. I. 1158 as rootstocks, showed no tristeza disease symptoms.

The results of tests of these lemon varieties as tops over sour orange rootstocks are not definite at this time except in the case of the Columbia sweet lemons which as tops over sour orange show tristeza disease symptoms.

*Mandarins, Tangerines and Hybrids.* The growth of Barao and Valencia sweet orange tops and the Leonardy and Duncan grapefruit tops over the 17 varieties of mandarins and tangerines tested has been apparently healthy as noted in Table 1. At the same time it can be seen that all of the varieties of mandarins, tangerines, and hybrids listed in this group and tested as tops over sour orange rootstocks have been found to show definite symptoms of tristeza disease.

TABLE 1  
RESULTS FROM INOCULATION OF VARIOUS CITRUS STOCK-SCION COMBINATIONS WITH THE TRISTEZA VIRUS IN BRAZIL<sup>1</sup>

List of Varieties	Tristeza Disease Symptoms on Stock-Scion Combination							Stock: Sour Orange Scion: Listed Variety
	Scion: Sweet Orange		Stock: Listed Variety		Scion: Grapefruit		Duncan	
	Barao A	Barao B	Valencia	Leonardy	Leonardy	Duncan		
<i>Citrus sinensis</i> (L.) Osbeck Sweet Oranges								
94. Pincapple	-	-	-	-	-	-	-	+
95. Valencia	-	-	-	-	-	-	-	+
96. Florida Sweet Seedling	-	-	-	-	-	-	-	+
97. Hamlin	-	-	-	-	-	-	-	
98. Parson Brown	-	-	-	-	-	-	-	
<i>Citrus Limon</i> (L.) Burmann Lemons								
61. Harris Lemon	+							
66. Lemon PI 136469	+	+	+					
64. Columbia Sweet Lemon	-	-						+
65. Sweet Lemon PI 1158	-	-	-		-			
<i>Citrus reticulata</i> Blanco Mandarins, tangerines and hybrids								
45. Cleopatra	-	-	-		-	-	-	+
47. Dancy	-	-	-		-	-	-	+
48. Oneco	-	-	-		-	-	-	+
49. Temple	-	-	-		-	-	-	+
50. Mandarin PI 10630	-							+
51. Mandarin PI 117477	-	-						+
52. Mandarin PI 114412	-							+
53. Swatow PI 10032	-	-						+
54. Swatow PI 10031	-	-						+
55. Swatow PI 14054	-	-	-					+

[illegible]

Table 1—(Continued)

List of Varieties	Tristeza Disease Symptoms on Stock-Scion Combination						
	Stock: Listed Variety		Scion: Grapefruit		Duncan		Stock: Sour Orange Scion: Listed Variety
	Barao	Sweet Orange	Barao	Valencia	Leonardy	Duncan	
	A	B					
75. Bigardier	+	+	+	+			—
76. Florida Bitter Sweet	+	+	+	+			—
77. Paraguay Sour	+	+	+	+			—
78. Rehoboth Palestine	+	+	+	+		+	—
79. Spain Sour	+	+	+	+			—
80. Tunis Sour	+	+	+	+			—
81. Dummett Bitter Sweet	+	+	+	+			—
82. Dummett Sour	+	+	+	+			—
83. Egyptian Sour	+	+	+	+		+	—
85. Bitter Sweet Stow Selection	+	+	+	+		+	—
<i>Citrus grandis</i> (L.) Osbeck Pummelos and Shaddocks							
86. Ogami Pummelo	+	+	+	+			—
87. Thong Dee Pummelo	+	+	+	+			—
88. Siamese Pummelo	+	+	+	+			?
89. Nakorn Pummelo	+	+	+	+			+
90. Cuban Shaddock	+	+	+	+			+
111. Tau Yau Pummelo (C.E.S. 2583)	+	+	+	+			+
113. Flemmings Shaddock (C.E.S. 578)	+	+	+	+			?
114. Hawaiian Shaddock (C.E.S. 454)	+	+	+	+			?
<i>Citrus paradisi</i> Grapefruits							
91. Leonardy	?	?	?	+		?	+
92. Foster							+

93. Duncan	+	+	+	+	+	+
102. Poorman's Orange	+	+	+	+	+	+
<i>Citrus longispina</i>						
125. C.E.S. 754	?		?			+
<i>Poncirus trifoliata</i> (L.) Raf.						
2. Trifoliata (Large Flowered)	-	-	-	-	-	-
<i>Poncirus trifoliata</i> x <i>Citrus sinensis</i>						
Citranges						
22. Savage	-	-	-	-	-	?
27. Saunders	-	-	-	-	-	+
28. Troyer	-	-	-	-	-	-
24. Rusk	-	-	-	-	-	+
<i>Poncirus trifoliata</i> x <i>Citrus paradisi</i>						
Citrumelos						
9. Citrumelo PI 4477	-	-	-	-	-	-
15. Citrumelo PI 4475	-	-	-	-	-	-
128. Winterhaven Citrumelo	-	-	-	-	-	-
<i>citrange</i> x <i>Citrus sinensis</i>						
18. Citrangor PI 42681						+
<i>Fortunella</i> Hybrid						
100. Nippon Kumquat	+	+	+	+	+	+
Unclassified						
104. Natsu Mikan	?	?	?	?	?	+

(<sup>1</sup>) Nursery test plantings established in August 1947, budded in Jan. and Feb. 1948. Barao B sweet orange buds were obtained from apparently healthy but virus infected orchard trees. Barao A and Valencia sweet orange and Leonardy and Duncan grapefruit buds were obtained from virus free seedlings. All apparently healthy plants were inoculated with viruliferous aphids in April and May 1948 and reinoculated in July and August. In above Table positive Tristeza symptoms indicated by +, apparently healthy growth with no Tristeza symptoms indicated by -, and questionable symptoms by a ?. Results are based on readings taken through August 1948.



*Tangelos.* In the case of the first 9 varieties of tangelos listed in Table 1, all the sweet orange and grapefruit tops tested over these varieties as rootstocks have to date developed apparently healthy growth. In contrast to this the sweet orange and grapefruit tops so far tested over the Thornton, Watt, Pina, and Tangelo 52018-W-2F, as rootstocks, have shown tristeza disease symptoms.

All of the tangelos tested to date as tops over sour orange rootstocks have shown tristeza disease symptoms.

*Tangor.* Only one tangor has been tested and this only as a top over sour orange rootstock in which instance it was found to show definite symptoms of tristeza disease.

*Sour and Bittersweet Oranges.* The sweet oranges Barao and Valencia, and the grapefruits Leonardy and Duncan, as tops over 15 sour orange varieties as rootstocks, have shown tristeza disease symptoms. On the other hand all of these 15 varieties of sour oranges, as tops over other sour oranges as rootstocks, have developed apparently healthy growth.

*Pummelos and Shaddocks.* The sweet orange and grapefruits tested as tops over the 8 varieties of pummelos and shaddocks listed have shown symptoms of tristeza disease.

These 8 varieties when developed as tops over sour orange rootstocks have shown some variations in their reactions. The Nakorn pummelo, Cuban shaddock, and Flemming's shaddocks have shown definite disease symptoms. In the case of other varieties it would seem desirable to await further developments in the

current tests before making a definite classification as to their reactions.

*Grapefruits.* At the present time we can report on only 4 varieties in the grapefruit group but additional varieties are being grown for subsequent testing. Of the varieties tested the reactions of the Leonardy and the Duncan are of particular interest because they have been used as tops over a large number of other citrus varieties as rootstocks and thus it has been possible to compare and note some differences in their reactions. In general, over nontolerant rootstocks such as sour orange, the symptoms of tristeza have been more striking and have appeared sooner on the Leonardy grapefruit tops than on the Duncan grapefruit tops. In contrast when these grapefruits were used as rootstocks the tristeza disease symptoms were more distinct and appeared sooner on the sweet orange tops over Duncan than on comparable tops over the Leonardy variety. These differences in reactions may eventually lead to a better understanding of the tristeza virus in relation to host responses.

The Poorman's orange has been included in the grapefruit group because it is said to be a grapefruit and is sometimes called New Zealand Grapefruit, or Indian Pomelo'. Certainly its reactions to the tristeza virus would indicate that it is closer to the grapefruit than it is to the sweet orange group. This perhaps illustrates the importance of genetic and physiological differences that may play an important part in plant variety responses to the tristeza disease.

*Citrus longispina.* The Barao sweet orange tops over *Citrus longispina* as a rootstock show only indistinct or mild symptoms that may or may not develop later into typical tristeza symptoms.

<sup>1</sup>Swingle, W. T., Botany of Citrus. In Webber and Batchelor, The Citrus Industry; California University Press, 1943.

This variety has been included in this report because it is an odd variety and the symptoms of tristeza on *Citrus longispina* tops over sour orange rootstocks are definite.

*Poncirus trifoliata* and *Hybrid*. As a whole the growth of *Poncirus* and the hybrids of *Poncirus* in Campinas has been comparatively slow, thus the tests of the varieties in these groups has been somewhat retarded. As shown in Table 1 the growth through August 1948 of the sweet orange and grapefruit tops over *P. trifoliata* has remained apparently healthy. Likewise the growth of *P. trifoliata* over sour orange as a rootstock has remained apparently healthy. Also the growth of the sweet orange and grapefruit tops over the citranges and citrunelos in the combinations as noted in Table 1 have remained apparently healthy. In contrast to this apparently healthy growth is the development of tristeza disease symptoms on the Saunders and Rusk citranges and on Citrangor P. I. 42681 when these varieties are grown as tops over sour rootstocks. The plant reactions in this group are being followed with considerable interest and although it is too early to reach definite conclusions it seems likely that some may prove to be satisfactory rootstocks at least as measured by the apparently healthy development of sweet orange tops in the presence of the tristeza disease.

*Fortunella Hybrid*. The Barao and Valencia sweet orange, and the Duncan grapefruit, tops over Nippon kumquat as a rootstock have shown early and severe symptoms of the tristeza disease. It may be said that the disease symptoms have even been more striking over Nippon than they have been over some of the sour orange rootstocks.

*Unclassified*. The citrus variety received under the name Natsu Mikan has developed definite symptoms of tristeza when budded and grown as a top over sour orange rootstocks. When Natsu Mikan was used in the tests as a stock for the Barao and Valencia sweet orange and the Leonardy and Duncan grapefruit tops, the development of questionable mild disease symptoms followed. The further development of symptoms or recovery will be followed with interest.

#### DISCUSSION

Although the tristeza disease of citrus and the "quick decline" of sweet orange trees may not be exactly the same, their similarities and potential importance are such that citrus growers are justified in expressing great concern and in having special interest in the tests that are being carried out cooperatively by the Instituto Agronomico de Sao Paulo, and the United States Department of Agriculture, Division of Fruit and Vegetable Crops and Diseases, at Campinas, Brazil. It is the purpose of this discussion to point out some aspects of the current investigations that should be of interest and value to the citrus growers and to other scientific workers who may be concerned with studies of tristeza or a similar virus disease of citrus.

With respect to efficiency in the methods employed in the testing of citrus varieties as rootstocks, it was found that results were obtained in a relatively short time (3-5 months from date of budding) when buds from a virus infected but apparently healthy sweet orange tree were employed. When buds from virus free seedlings were employed it was considered desirable to wait for the development of one flush of growth before inoculating with

viruliferous aphids. This prolonged the time required to obtain results (5 months and more from date of budding) and involved the additional work of collecting aphids and making the inoculations.

By using both viruliferous and non-viruliferous buds of the Barao sweet orange it was hoped that we might observe some early reactions on some specific stock-scion combination that could serve as a rapid and accurate diagnosis of the presence or absence of the tristeza virus. Careful records were taken of the budding success and at first it was thought there were certain stocks that might possibly serve as test plants because of the poor take of viruliferous buds. However, repeated test buddings indicated that the budding success or failure was due to other factors and could not be directly related to the presence or absence of virus in the buds used.

In the present tests it was observed that the first flush of growth from viruliferous sweet orange buds even over sour orange rootstocks, was usually apparently healthy. In fact early growth records on the development of these viruliferous buds indicated that the sour orange rootstocks were particularly good stocks for the Barao sweet orange. However this advantage in growth of the sweet orange top over sour orange rootstocks came to an abrupt halt when the symptoms of the tristeza disease appeared.

The experience gained, however, in the use of viruliferous buds in the stock tests indicates that in areas where the tristeza disease occurs a grower could use infected buds to establish a new orchard provided he uses tolerant rootstocks such as found in the sweet orange

and mandarin groups. This knowledge is of value especially in areas where the disease is prevalent and to growers who have a particular variety of sweet orange that they wish to continue producing. Under tristeza disease conditions the securing or developing of a source of virus free buds would be expensive and fortunately this would not appear to be necessary.

It is important to realize that sweet oranges regardless of rootstocks can be definite carriers of the tristeza virus and where the disease occurs it may be expected that sooner or later all of the sweet orange tops in an orchard may become infected. Once the tristeza virus has become established in an area its eradication would be extremely difficult if not impossible. The only solution to the problem at present rests on the basis of using tolerant rootstocks over which sweet oranges may develop in an apparently healthy condition in spite of virus infection. On the basis of this concept an analysis of the general reactions to date by citrus groups should be of interest. It should help to indicate which groups are most likely to furnish varieties or hybrids that could serve as tolerant rootstocks over which sweet oranges and grapefruits could develop in spite of tristeza virus infection.

In the following attempt to analyze the reactions of citrus groups to the tristeza virus the reactions secured in both Stock and Sour tests have been used because they afford two means of measuring and comparing the citrus variety responses.

Only 4 lemon varieties were included in the first group of plant material tested but it is of interest that in the Stock test results reported in Table 1, 2 of the lemon varieties have been found to be

tolerant rootstocks and 2 have been found to be nontolerant stocks. Unfortunately the testing of these varieties over sour orange rootstocks has not been completed. It is, however, worthy of note that the Columbia sweet lemon has shown definite tristeza symptoms over sour orange as a rootstock. This is not the type of reaction expected of true lemons such as Eureka, for in orchards, the Eureka lemon has been observed to develop well over sour orange rootstock even in areas where tristeza disease is prevalent. The finding of distinctly different types of reactions in the presently tested lemon varieties suggest that these varieties differ appreciably. It may be that a more detailed knowledge of their genetic origin would help to clarify these differences. In any event the testing of additional lemon varieties appears to be desirable and is being carried on.

The consistent reaction of the sweet orange and mandarin varieties tested is of special interest and importance. So far in the Stock tests all varieties have been found to be tolerant rootstocks while in the Sour test all have been found to show tristeza symptoms over sour orange rootstocks. If there are any sweet oranges or mandarins found that do not in subsequent tests show disease symptoms over sour orange rootstocks they would then be interesting and important exceptions.

The testing of the pummelos, shaddocks and grapefruits is not yet completed but the results to date in the stock test show that none of the varieties tested could be considered as satisfactory stocks for either sweet oranges or grapefruits under tristeza conditions. The fact that many of these varieties have also shown tristeza disease when developed as scions over sour orange

rootstocks, and that they are nontolerant as rootstocks for sweet orange, helps to distinguish them as having reactions distinctly different from those encountered in the Lemon group or in the sweet orange and mandarin group, and is also different than that encountered in the tests of sour orange varieties. Again it should be noted that the tests, especially the Sour tests, are not yet completed for the pummelo and shaddock varieties so that final judgment of varietal reactions cannot be made except where positive disease symptoms have been observed. It would seem, however, that the finding of tolerant rootstock among the pummelos, shaddock, or grapefruits would not be as likely as in the mandarin, sweet orange, or lemon groups.

Having in mind the general reactions observed to occur in the mandarin group which has yielded tolerant rootstocks and in the grapefruit group which has given nontolerant rootstocks, it is of interest to observe the results secured from the testing of a number of tangelos. Certain of the tangelos appear to follow the reactions characteristic of one parent *Citrus paradisi* (grapefruit) and show distinct symptoms of tristeza when used as a stock for sweet orange. In contrast other tangelos appear to follow the reaction of the other parent, *Citrus reticulata* (mandarin) and to date have served as good stocks for sweet orange in spite of inoculations and even in the case where viruliferous Barao B buds were used. In comparison with these two types of reaction in the Stock test, all tangelos tested to date as scions over sour orange rootstocks have shown tristeza disease symptoms.

From the discussion above and from the data presented in Table 1, it can be seen that there are several types of re-

General Botanical Group	Stock Test	Sour Test
	As Rootstocks for Sweet Orange and Grapefruit	As Scions over Sour Orange Rootstocks
	Symptoms	Symptoms
Sweet Oranges	--	+
Mandarins	--	+
Some Lemons	--	+
Some Tangelos	--	+
Sour Oranges	+	--
Grapefruits	+	+
Some Pummelos	+	+
Some Shaddocks	+	+
Some Tangelos	+	+
<i>Poncirus trifoliata</i>	--	--

lated reactions when the results of the Stock and Sour tests are compared. These comparative reactions may be outlined as shown in table above.

The above outline is admittedly incomplete but it does offer a framework on which to differentiate the comparative reactions and as the studies progress more specific data will be obtained and it seems entirely possible that we will find some citrus varieties that may show symptoms of tristeza even as unbudged seedlings.

On the basis then of the results secured up to the present time it would seem that the continued testing of mandarins, lemons, tangelos and trifoliate orange as rootstocks for sweet orange and grapefruits is definitely worthwhile. In addition the securing of distinct reactions in hybrids such as the tangelos and as indicated by the early results in the *Poncirus* hybrids strongly suggests the desirability of securing or making crosses between mandarins and sour orange and between sweet oranges and sour oranges. It might then be possible to find a hybrid that would combine the desirable

characters of the sour orange, such as its resistance to gummosis and foot rot, with the desirable tolerance to the tristeza virus. The careful development of such crosses and their subsequent testing appears to be very much worthwhile.

The result presented in this progress report indicate that when the tristeza virus enters and spreads in an area one may expect that practically all commercial varieties of citrus over sour orange rootstocks, with the exception of certain lemons, will sooner or later become diseased. At the same time, however, the results obtained indicate that the commercial citrus varieties over sweet orange and mandarin, and probably over some hybrids, may not suffer even though they become infected with the tristeza virus. As the work in the Stock and Sour Tests here in Campinas progresses and as additional observations and data are obtained they will be presented in subsequent reports. It is also a part of the definite plan of the Instituto Agronomico to transplant the tolerant stock scion combinations to the orchard where their development and behavior

with respect to tristeza can be followed over a longer period of time and where their resistance to other diseases and their suitability for culture in Brazil can be studied.

### SUMMARY

The methods and procedures employed in the establishment of the Citrus Stock Test and the Sour Test are briefly described. Data are given on the presence, or absence, or questionable occurrence of tristeza disease symptoms on 345 citrus stock scion combinations following inoculation with the tristeza virus.

The sweet orange and mandarin and tangerine varieties tested have to date proved to be tristeza-tolerant rootstocks for the various sweet orange and grapefruit varieties employed as tops even though the plants have been inoculated and are carriers of the tristeza virus.

Results from the present tests show that none of the 15 varieties of sour orange tested could be considered as a satisfactory rootstock under tristeza

disease conditions. Likewise it is indicated that the grapefruits, shaddocks, pummelos and some lemons, some tangelos, and the kumquat hybrid tested would not be satisfactory rootstocks for sweet oranges or grapefruits when subject to tristeza virus infection.

The distinctly different reactions obtained in tests with the lemon varieties and especially with the tangelo varieties and early results in the *Poncirus* and *Poncirus* hybrid groups indicates the desirability of including in the tests known hybrid crosses especially between mandarin and sour orange and between sweet and sour orange.

The current tests are being continued and expanded to include other varieties and at the Instituto Agronomico it is planned to transplant the rootstock-scion combinations that show tolerance to the tristeza virus to larger field plantings where their subsequent development can be followed and where their resistance to other disease and their adaptability to local conditions can be studied.

## TRISTEZA DISEASE IN JAVA

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Florida horticulturists and citrus growers are well aware of the danger of Quick Decline disease to the groves that are the backbone of the State's agriculture. In one of his last articles about the Tristeza disease in *The Proceedings of the Florida State Horticultural Society*, Dr. Walter Swingle wrote: "It is important for citrus growers to be given as promptly as possible information as to

stock adapted to all localities so that if any new rootstock trouble does appear they will know promptly what stocks are best for replacement. It is quite possible that State and Federal Experiment Stations might be able to work out techniques for replacement of rootstocks that are beginning to fail."

Because of the concern of men like Dr. Swingle, I believe my observations in Java may be of interest to citrus specialists in Florida. For a long time Indonesia has had a disease with about the same symptoms as Tristeza and though

horticulturists never definitely learned its exact cause, they did develop trees which successfully resisted the disease.

When I arrived in Java in 1914, all citrus trees were obtained by marcots and seed. Oranges, shaddocks, mandarins, limes, lemons, and citrons occurred locally all over Indonesia. Most of the oranges, mandarins, lemons, and citrons grew at about 3,000 feet above sea level and the shaddocks and some special lowland mandarins between sea level and 500 feet above.

To insure faster and better propagations, horticulturists started budding trials in 1915 and since shaddocks produced the best growing seedlings, they used shaddock as a stock. However, within a year's time, all oranges, mandarins, and lemons (most Khatta's) budded on shaddock stock died in a chlorotic condition. This was ascribed to normal incompatibility.

Then we obtained rough lemon (*Citronella*) seeds from Australia, and in the years after 1920, we budded all local oranges, mandarins, shaddocks, and imported orange varieties on rough lemon stock.

At the same time, I tried a very abundant fruiting sour mandarin as a stock. This stock, which grew a bit more slowly but produced when used as a stock a better quality fruit than rough lemon, was established by that time under the name of Japanese lemon. In some mountainous regions above 3,000 feet, with a rainfall of about a hundred inches a year, gummosis occurred and attacked the sweet oranges on their own roots and also those on stocks of rough lemon and Japanese lemon.

About 1930, we ordered from Florida new collections of oranges on sour stock and a large quantity of sour orange

seeds. All imported oranges on sour orange stock died within 2 years after being planted. Some imported grapefruits on sour orange stock, like Marsh Seedless, Duncan, McCarty, and Triumph, reached a height of 5 feet, but stopped growing, turned yellow, and began dying slowly.

Budding experiments on sour orange grown from imported seeds gave no better results. During the last 25 years in Indonesia, the so-called Japanese lemon has always given very good results—second only to rough lemon.

The Japanese lemon stock was not a strong grower, but it gave fruits of very good quality, already 3-4 years after budding with different orange varieties. Mandarins and shaddock varieties a year later, with the exception of one very good variety of a Chinese mandarin with a thin skin, which fruited as a rule 3 years after budding. It is highly probable that this so-called Japanese lemon is identical with the Rangpur lime, described by Webber and Batchelor in *The Citrus Industry* on pp. 619 and 626-628.

On page 60 of my book, *Fruit and Fruit Culture in the Dutch East Indies*, 1931, I wrote that the Japanese lemon may be considered one of the forms of the Jambhiri group, described by Bonavia in his book, *Oranges and Lemons of India and Ceylon*, p. 60.

It has a very sour pulp. The peel does not separate as easily as in most forms of *Citrus nobilis*. In this respect it resembles the King Orange, *Citrus nobilis*. Lour, var typica (Fruits and fruit culture in the Dutch East Indies). In India the Jambhiri group has also been proved to possess excellent qualities as a stock.

My conclusions do not agree with those of Dr. Bitancourt, the Director do Instituto Biologico de Sao Paulo in

Brazil, who remarked to Dr. Webber (see *The Citrus Industry* p. 627) that the Rangpur lime some 15 years ago was one of the most commonly used rootstocks in Brazil. Its popularity was due primarily to its general use by nurserymen, who favored it because of its rapidity of growth and the ease with which good-sized nursery buddings could be produced. Subsequent experience showed that the budded trees grew well for several years, then gradually slowed down in growth and declined. Thus in Brazil the Rangpur is no longer considered to be a satisfactory rootstock.

According to Schultz (*The Citrus Industry*, p. 627), the Rangpur lime has given promising results as a rootstock in tests made by the Agricultural Experiment Station at Tucuman, Argentine, with scion varieties of sweet orange, mandarin orange, and grapefruit. In comparison with trees grown on such rootstocks as sour orange, grapefruit, rough lemon, and trifoliate orange, the trees on Rangpur lime roots exhibited greater vigor and greater resistance to hot winds and drought, were more precocious and fruitful, and matured their crops earlier. These results, recorded in 1938, were based on young trees planted in 1933. Schultz reported the results as only preliminary.

Results from similar studies in Indonesia have been even more convincing. From 1920 until the Japanese invasion, Rangpur lime proved a very satisfactory stock in different parts of Indonesia. Hence, considering the threat of Tristeza or Quick Decline diseases to citrus-grow-

ing countries which have thus far escaped them, it seems important to remember that the Japanese lemon or Rangpur lime has proved satisfactory in tropical countries with a marked infestation of Tristeza. Another great advantage of the Rangpur lime is that it apparently reproduces nearly true to type from seed. The colored drawing in my book, *Fruit and Fruit Culture in the Dutch East Indies*, gives an accurate picture of the fruit as it appears in Java.

We tested in later years many other citrus species and hybrids besides the Japanese lemon. At this moment I'm still not sure what plantings in the experimental plots survived the Japanese occupation of Java. One species, which had already given promising results 2 years before World War II, was a sour orange type, which was imported from the botanical garden in Paradenija, Ceylon. Until the outbreak of war in Java, sweet oranges and mandarins grown on this stock had given no signs of Tristeza.

This last information I got from Dr. G. J. A. Terra, my successor as head of the division of horticulture in Java in 1937, who was in Miami in 1947 on a study inspection in the United States on drought-resistant annuals.

Another stock tried in Java some years ago was the Cleopatra mandarin. Buddings from sweet oranges on the Cleopatra mandarin remained in healthy condition, but our interest diminished because the Cleopatra mandarin was a very slow grower at 3,000 feet. That is the height above sea level where most of our mandarins are cultivated.



# INSURANCE AGAINST A FOREIGN INVADER

T. RALPH ROBINSON

Terra Ceia

There are enemies other than human that at times have threatened our happiness and our economy if not our actual lives. We have been hearing for several years past of the dread inroads of a new virus disease of citrus that has killed millions of bearing orange trees in South America. In Brazil it is called "Tristeza"—the sad disease. Sad it must be. In California "Quick decline" appears to be something very similar if not identical. In each case it kills only trees budded on the sour orange rootstock. Oranges, grapefruit, and tangerines so budded die in 3 to 5 years—lemons, whether scions or rootstock are immune.

In South America it has been demonstrated that the virus is spread by a single species of aphid, the "black aphid," which is not known to exist in this country. However recent conversations with travelers who have come by air from South America readily dissipate any false feeling of security. Our plant inspection service is doing a fine task in keeping out harmful insects and diseased plants but the task is becoming almost beyond human capacity, with the enormous increase in travel. A bouquet of flowers with a few aphids hidden away, or a stick of bootlegged budwood supposedly disease-free might bring the dread disease to our shores. Mention of the budwood brings to mind that a twig from an orange tree budded on an immune stock and to all appearances entirely free of the disease may yet be a *carrier* of the virus and capable of transmitting it

to another orange tree budded on the sour orange rootstock. There may prove to be insects other than the black aphid capable of transmitting the virus as is apparently the case in California.

It is true that Florida is in the best strategic position of any large producing citrus area in the world, since the great bulk of the Florida crop (about three-quarters) comes from trees budded on stocks that make the plant immune to the virus disease—budded chiefly on the rough lemon rootstock. Yet it is also true that a great deal of our very finest fruit is derived from the so-called hammock groves, where the sour orange has been the favored rootstock since the earliest days of citrus planting in Florida. The owners of these fine groves could ill afford to see them gradually wiped out. Their replacement would be an extremely expensive affair, and a great disaster to the State and to the Nation.

Experiments have shown that if a tree exposed to the virus infection is inarched to an immune stock, such as the rough lemon, Cleopatra mandarin, sweet orange or citrange it may be saved from destruction—provided this is done before the disease gets a firm foothold.

Now the reason for this paper is to describe a method of inarching that may be successfully applied to old bearing trees. The writer saw this method being used in a famous old grove near Lake Thomotosassa in Hillsborough County—the Belvedere Grove. The grove is owned by Mrs. S. R. Stebbins. This was in March of 1934. The trees, about 60 years old, had grown so large that they shaded the ground almost completely



*Rough lemon seedling used as an inarch on an old orange tree. A novel feature is placing the inarch so high on the trunk, as explained in the text.*

and footrot was beginning to take some of the veteran trees. Mrs. Stebbins found that the textbook method of inarching—planting small seedlings near the base of the tree and approach grafting them into the trunk—simply did not work. The small shaded seedlings just could not make headway under the circumstances.

She then decided to try something different. She had her seedlings, —in this case rough lemon—grown up to 8 or 10 feet tall, full of vigor and easily transplanted. She had two or three of these seedlings planted around each of the affected orange trees *at a distance of 2 to 3 feet from the base of the tree*. The approach graft was made often at a height of 4 to 6 feet from the ground, so high that in some cases a person could walk around the trunk of the tree between the trunk and the inarched seedlings. In most cases a prompt union was secured. These whip-like stems within a year's time were 2 to 3 inches in thickness and within another year or two were quite capable of bearing the entire burden of supporting the 30-foot tree a foot or more in diameter. In fact, in several instances observed the original root system of the old orange seedling was entirely rotted away. Such trees continued to bear fine crops of oranges sustained only by the substitute root system.

Now we may be fortunate enough never to have to resort to such a method of salvaging groves budded on the sour orange rootstock. Would it not, however, be wise to take out an inexpensive insurance policy? By that is meant the planting and maintaining in numerous neighborhood nurseries seedlings of immune rootstocks. As to the choice of rootstock much will depend on the soil

and on the variety of fruit being grown. The rough lemon is the stock par excellence for most of the varieties grown in Florida. While commonly regarded as mainly suited to deep sandy soils, such as those found in the sand hills of the Ridge section, it is a very adaptable stock. It can be used successfully in low hammock soils if the methods of culture followed are adapted to the location. As a compromise between the rough lemon and the sour orange rootstocks the Cleopatra mandarin has come in much favor of late. It seems best adapted, however, to a medium grade of well-drained soil and is commonly regarded as unsuited to low moist locations, especially where there is at times a high water table. This is the condition that is often encountered in the coastal hammocks of Florida. It is especially adapted for use with the "fancy" varieties such as the Temple and the tangelos which do not as a rule produce high quality fruit for a number of years when budded on the rough lemon rootstock. However if inarching is done using the rough lemon after the initial years of rapid growth have passed, say 6 to 7 years, there is no reason to fear that the rough lemon rootstock will prove seriously detrimental to the character of the fruit produced. There remains the sweet orange and the citrange as possible choices. The citrange has its advantages in cold locations but the supply of seed is limited. The sweet orange is probably more subject to footrot than any of the above stocks but with proper precautions that should not prove a serious handicap. None of these stocks are likely to prove as easily inarched or approach grafted as the rough lemon, which insures a union being promptly secured in a large majority of cases.

In the case cited—that of the Belve-

dere Grove—the actual work under Mrs. Stebbins' direction was done by an intelligent negro, an experienced "grove hand" not by a high-priced tree surgeon. There is no reason why such a job could not be done by a grove owner or any of his helpers who have had a little experience in propagation.

But it took a person of imagination and initiative like Mrs. Stebbins to forsake the textbook methods and devise a method that would work on old trees that had reached a size where they shaded out the ground almost completely. By planting the seedlings at some distance from the tree trunk a space could be chosen away from the main crown roots thus avoiding the sort of fatal competition that killed off the small seedlings planted close to the base of the trunk. To do this the seedlings used had to be tall and vigorous. Thus, we may owe Mrs. Stebbins a great debt of gratitude to have shown us the way, if ever we are forced to work over our old sour stock groves by the inarching method.

Even if we escape the Tristeza menace the method has its application in many old groves suffering from footrot or senescence. A recent inspection of this famous old grove shows these inarched trees in a fairly thrifty condition carrying heavy crops of oranges.

The value and application of the effort that has been made by Drs. Swingle, Webber, Camp, and others to warn us against the serious danger almost at our door must depend entirely on the recognition and use by us of all available measures of protection. One of these measures would seem to be the suggested establishment of nursery grown seedlings of immune varieties immediately available for inarching if the strange disease should gain entrance to our shores. One would not need to wait until the disease actually invaded the grove or until immune seedling stocks could be grown. Better it would seem to be to start inarching at once as a measure of insurance against later disaster.

## REPORT ON FERTILIZER EXPERIMENTS IN AN ORANGE GROVE IN THE EASTERN EVERGLADES

W. T. FORSEE, JR. AND T.W. YOUNG<sup>1</sup>

The Davie citrus area in which these experiments were located, lies on the eastern edge of the Florida Everglades about 10 miles southwest of Fort Lauderdale. The topography is essentially flat. Drainage is primarily by gravity through a series of lateral canals and two main outlet canals. The water table

is held at an approximate average depth of three feet. The surface layer of the soil in most of the area originally consisted of a fibrous sawgrass (Everglades) peat from 18 to 24 inches deep. The citrus trees are planted on broad low ridges or beds built up from a mixture of the top soil and the underlying sand. Due to mixing with the sandy subsoil, oxidation of the organic soil and compaction, the mineral content of the surface layer has increased and the depth of the surface layer decreased in propor-

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tion to the rate of oxidation of the original peaty material.

The soil of the area selected for these experiments was a Davie fine sand, rather typical of that section. The experiments have been described in previous publications (5) (2). The trees, Lue Gim Gong variety, were set in 1929 and the experimental treatments started in 1934. The grove had received only very small amounts of fertilizer during the five-year interim between planting and establishment of the plots.

The experimental treatments initiated in March 1934, consisted of applying 16 different fertilizers with varying N-P-K ratios derived from various sources of

base materials to triplicate plots. Only one application was made annually in the spring until 1942. Beginning at this time a second application was made in the fall. Occasional supplemental applications of minor elements were made uniformly over the plots. Yield data were taken each year from 1937 to 1945, inclusive. At the end of this period rooting across the middles between trees under different treatments was beginning to occur. This rendered the plots unsatisfactory for further investigations of this kind. Therefore, the experiments were terminated with the 1945 harvest.

The average yearly weight of fruit produced by each tree for the nine har-

TABLE I  
AVERAGE ANNUAL YIELD OF FRUIT PER TREE FOR THE NINE-YEAR PERIOD COVERED BY THE EXPERIMENT.

No. <sup>1</sup>	Treatment <sup>2</sup>	Average Yield lbs. per tree	Statistically Equal at:	
			5%	1%
16	3-6-48 (muriate) <sup>3</sup>	285	a	a
7	3-6-24	283	a	a
14	3-6-12 (di-calcium phosphate)	270	a	ab
11	3-18-12 (rock phosphate)	269	a	ab
2	0-12-24 <sup>4</sup>	267	a	ab
6	3-6-12	261	ab	ab
12	3-6-12 (colloidal phosphate)	259	ab	ab
13	3-6-12 (basic slag)	257	ab	ab
10	6-6-12	255	ab	ab
1	0-12-12 <sup>5</sup>	249	ab	ab
9	3-12-24	248	ab	ab
8	3-12-12	225	bc	bc
5	6-0-12	186	cd	cd
4	3-0-12	160	d	d

<sup>1</sup>Treatment numbers are listed in the order of decreasing yields.

<sup>2</sup>Treatments followed by the same letters are statistically equal.

<sup>3</sup>For the first four years this treatment was a 3-6-12 with potassium carbonate as the potash source. During 1938, 39, 40 and 41 the treat-

ment was a 3-6-24 using muriate. In 1942 the formula was increased to the 3-6-48.

<sup>4</sup>Unless otherwise indicated, P<sub>2</sub>O<sub>5</sub> was derived from superphosphate, K<sub>2</sub>O from sulfate of potash and N, 1/3 from castor pomace, 1/3 from nitrate of soda and 1/3 from ammonium sulfate.

<sup>5</sup>Changed in 1939 from 0-0-12.

<sup>6</sup>Changed in 1939 from 0-0-6.

vests is recorded in Table 1. The treatments are listed in the order of their decreasing yields along with columns showing those treatments that are statistically equal or different at the 5 percent and 1 percent points. Two of the treatments are not included in this discussion because they were changed during the course of the experiment and their yields have no bearing on the over-all results. The effects of treatment on yield may be evaluated from the standpoint of the three elements in the fertilizer that were varied, namely, nitrogen, phosphorus and potassium.

The rates of N in the fertilizers for the various treatments were 0, 3 and 6 percent, derived equally from nitrate of soda, sulfate of ammonia and castor pomace. The presence or absence of nitrogen in the fertilizer had no effect on yield as is evidenced by the fact that there is no statistical yield difference between treatments 2 and 9 or 1 and 8 (Table 1). The general condition of the trees in the no nitrogen treatments was equally as good as in any other treatment. The trees made good growth. Foliage was normal in size, color, density

and total nitrogen content. There was no marked difference in the results obtained from the 3 percent and 6 percent nitrogen treatments where phosphate and potash were held constant. Under the conditions of this experiment, no beneficial results were obtained from nitrogen fertilization. Unpublished data from a nitrogen experiment operated four years in an adjoining grove substantiate these findings. In the latter case the plots were on soil ranging from about 14 to 50 percent organic matter. No increase in yield was secured over no nitrogen from light, medium or heavy nitrogen applications applied at various times throughout the year. This was just as true for the plots on the lowest soil organic matter content as those with the higher content.

Superphosphate was used in the various fertilizer treatments at the rates of 0, 6 and 12 percent. Rock phosphate was used at the rate of 18 percent and colloidal phosphate and basic slag at 6 percent, based on the approximate total P<sub>2</sub>O<sub>5</sub> contents of the source materials. Phosphate treatment had a very decided effect upon yield (Table 1). The no

TABLE 2  
EFFECT OF PHOSPHATE TREATMENT ON ACIDITY, RIND THICKNESS, PREHARVEST DROP OF FRUIT AND NUMBER OF CULLS

No.	Phosphorus Treatment	Citric Acid in Juice <sup>1</sup> Percent	Rind Thickness <sup>1</sup> mm	Preharvest Drop of Fruit <sup>2</sup> Percent	Culls <sup>2</sup> Percent
4	no P <sub>2</sub> O <sub>5</sub>	1.99	5.03	70	46
6	6% P <sub>2</sub> O <sub>5</sub> (Super)	1.50	3.51	20	4
8	12% P <sub>2</sub> O <sub>5</sub> (Super)	1.37	3.77	13	7
11	18% P <sub>2</sub> O <sub>5</sub> (Rock)	—	—	14	5
12	6% P <sub>2</sub> O <sub>5</sub> (Colloidal)	1.67	4.13	25	10
13	6% P <sub>2</sub> O <sub>5</sub> (Basic slag)	—	—	27	9

<sup>1</sup>Samples collected 2/8/43.

<sup>2</sup>Average for the 1941, 1942 and 1943

harvest. Percentages calculated on the basis of the number of fruits harvested.

phosphate treatment show the lowest production rank for the nine years. Treatments 8 and 9 which received superphosphate at the highest rate during the entire period of the experiment ranked next to the no phosphate treatments, 4 and 5. This is perhaps due to the large amount of ammoniation on the high phosphate treatments which probably induced considerable early drop of green fruit. This factor will be discussed later. Yields from the slowly available sources of phosphate were all within the range of the best treatments. Dicalcium phosphate was probably more available than the other insoluble sources on this low pH soil. Rock phosphate was applied at three times the rate of the other materials. This may account for the fact that treatments 11 and 14 ranked higher in yield than treatments 12 and 13.

Treatments containing no phosphate

or low amounts of available  $P_2O_5$  produced fruit with a higher citric acid content and thicker rinds. Lack of phosphorus also induced a large amount of preharvest drop and the harvested fruit was soft and graded out a higher percentage of culls. These data are included in Table 2. Fruit from the no phosphate treatments was slightly smaller in size, had a rough, coarse texture, was somewhat elongated with a thick, wrinkled stem end and had a coarse structure with large juice sacks and a thick core. These differences with phosphate treatment have been discussed in detail in a previous report (2).

As early as 1941 ammoniation symptoms had become quite evident on treatments 8 and 9 which had received the heaviest superphosphate applications since the beginning of the experiment. The seriousness of this condition increased each year. In 1944 a nutritional

TABLE 3

THE EFFECT OF PHOSPHORUS TREATMENT UPON COPPER ASSIMILATION AS INDICATED BY LEAF AND FRUIT ANALYSES AND UPON THE INCIDENCE OF AMMONIATION IN THE FRUIT

Phosphorus Treatment		Water Sol. P in Soil, lbs. per Acre	Copper, ppm <sup>2,3</sup>				Ammoniation, percent	
Percent	Source		Soil <sup>4</sup>	Leaves <sup>4,5</sup>	Juice	Seed <sup>4</sup>	1944 Crop	1945 Crop <sup>6</sup>
none		4.2	185	9.6	0.57	10.5	0.4	0.12
6	Super	12.9	260	3.5	0.27	11.5	0.3	0.07
12	Super	34.0	263	1.9	0.15	3.4	24.0	0.05
18	Rock	13.5	—	3.6	—	—	0.1	0.00
6	Colloidal	6.3	—	7.7	—	—	0.1	0.01
6	Basic slag	7.6	—	7.1	—	—	0.1	0.04

<sup>1</sup>Based on total  $P_2O_5$  content of source materials used.

<sup>2</sup>Copper analyses were made spectrographically by Mr. T. C. Erwin of the Florida Agricultural Experiment Station, Soil Department, Gainesville.

<sup>3</sup>Numbers recorded are averages of all samples analyzed from each labeled  $P_2O_5$  group.

<sup>4</sup>Oven-dry basis.

<sup>5</sup>Average for two sets of samples representing old and new growth.

<sup>6</sup>Nutritional sprays, including copper, were used for this crop.

spray program including copper was initiated on the entire grove. This practically eliminated ammoniation from the 1945 crop (Table 3).

Since ammoniation is a symptom of copper deficiency, evidence is rather conclusive that the higher amounts of available phosphorus in the soil had interfered with copper assimilation by the trees. The extent and relation of copper deficiency symptoms as evidenced by ammoniation to phosphate treatment in this set of plots has been mentioned by Forsee and Allison (3). Copper analyses made on soil, leaf and fruit samples from certain treatments representing various levels of phosphorus supplied from soluble and insoluble sources are recorded in Table 3 along with the percent ammoniation.

The soil analyses for total copper indicate that the trees on the phosphate treated plots had excess to as much or more copper than those on the plots receiving no phosphorus. However, as the superphosphate treatment increased the assimilation of copper decreased as is evidenced by the copper contents of the leaves, juice and seeds. Leaf samples from the collodial and basic slag treatments show copper values intermediate between the no phosphate and the percent superphosphate treatments while samples from the rock phosphate treatment show copper values approximately the same as the 6 percent superphosphate treatments. This correlates with the water soluble phosphorus contents of the soil (Table 3) and indicates that copper assimilation by the tree is inversely proportional to the amount of active phosphorus in the soil.

In studying soils from rather widely different parts of Florida, Jamison (4) found little difference, by laboratory

methods, in the fixation of copper in the presence and absence of superphosphate. In lysimeter experiments on virgin Norfolk fine sand Erwin (1) found that copper in the plant was decreased and copper in the leachate was increased as the phosphorus in the soil was increased up to a certain level. Beyond this level of phosphorus the leaching of copper was depressed. While the data included in Table 3 and the experiments of Erwin (1) definitely indicate that soil applications of soluble phosphorus influence copper assimilation, this influence may be indirect and due to some factor other than straight fixation of copper by phosphate.

At the conclusion of the experiment the trees on the no phosphate plots were smaller and showed much less vegetative growth than the other treatments. The foliage was smaller with a somewhat narrow and stunted appearance. The small amount of phosphate carried by the castor pomace used as a portion of the nitrogen source in the mixed fertilizer and cross rooting between plots probably prevented the appearance of more serious phosphate deficiency symptoms.

Potash treatments during most of the experiment were 12 and 24 percent derived from the sulfate and 48 percent derived from muriate. As shown in Table 1, the two highest average yields were from treatments 1 and 7 (48 and 24 percent  $K_2O$ , respectively). These two treatments were consistently good producers throughout the entire period of the experiment. However, where nitrogen and phosphorus were held constant, the differences in yield with respect to potash were not statistically significant. The 48 percent potash treatment produced a relatively high percentage of large, coarse fruits that were



somewhat wrinkled and green, particularly around the stem end. Many were slightly misshapen. There was no difference between the various potash treatments with respect to tree growth or appearance so far as could be determined from observation.

The results of this eleven-year experiment may be summed up briefly. On most Davie soils (15 percent organic matter or over) nitrogen is not normally a necessary fertilizer ingredient. Phosphate fertilization is essential to satisfactory production over a prolonged period. The insoluble sources of phosphate may be used if applied at appropriate rates. A moderate amount of superphosphate (equivalent to about 1.2 pounds of  $P_2O_5$  per tree per year on mature trees) gives good results and is safer to use than larger amounts. The level at which potash would become a limiting factor in production is below 2.4 pounds of  $K_2O$  per tree per year. It is doubtful that rates of application much above this would prove profitable.

Muriate of potash is no more toxic or in any way inferior to other sources of potash.

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## A PROGRESS REPORT ON PHOSPHATE FERTILIZER TRIALS WITH ORANGES IN FLORIDA

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There is little published evidence on the effect of phosphate fertilization on citrus production and fruit quality in Florida, although it has been common practice to use mixed fertilizers rich in

phosphate almost since the beginning of the Florida industry. Forsee and Neller (10) have reported yield and growth responses of oranges to various phosphatic materials on the organic soils of the eastern Everglades, but there are no recent published data for the sandy mineral soils on which most of the Florida citrus plantings are made.

The purpose of this paper is to present a progress report on two long-term field experiments. Four levels of phosphate fertilization on oranges are compared in

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two locations. Both are on acid, well-drained, light sandy soils of the Lakeland series which are low in exchange capacity, and are typical of the major soil type used for citrus culture in Florida. This report is concerned with yield and growth data, soil changes, leaf analysis, and fruit composition. It is a somewhat condensed, less technical version of two papers which have been submitted for publication elsewhere (19, 21).

#### EXPERIMENTAL METHODS

*Plan of Valencia Experiments:* The first series of phosphate plots was established in 1942 in a block of Valencia oranges on rough lemon stock planted in 1923 near Dunedin in Pinellas County. This irrigated 10-acre grove on a hammock phase of Lakeland fine sand (formerly called Norfolk fine sand) was chosen for this purpose partly because it had received far less phosphate fertilization than most groves in Florida of comparable age. The grower's records revealed that during the first 11 years (1923 through 1933) after planting it received less than one-half as much  $P_2O_5$  per acre as nitrogen. In 1934 colloidal phosphate at the rate of 1,000 pounds per acre was applied to the soil. During the period from 1935 until 1942, most of the mixtures applied contained no phosphatic fertilizer materials, although small amounts of  $P_2O_5$  were, of course, contained in the organic nitrogen sources used.

A system of 20 plots was established on about  $4\frac{1}{2}$  acres of the most uniform portion of the grove. Each plot consists of 16 trees, and is completely surrounded by buffer rows. Since the planting distance is 15 x 25 feet, the fertilized area for each plot plus one-half of the area occupied by the surrounding buffer trees

is about 0.215 acres. Four treatments, arranged in random fashion, were established in each of five blocks.

During the experimental period 1942 through 1948 all plots and buffer trees received uniform poundages (applied by machine) of mixed fertilizers containing nitrogen, potash, soluble magnesium, several minor elements, and dolomitic limestone filler. With the exception of the first year, no organic nitrogen was applied. The sources of nitrogen were sulfate of ammonia, ammonium nitrate, and nitrate of soda. Potash was derived from sulfate of potash-magnesia and muriate. Soluble magnesium was obtained from sulfate of potash-magnesia. Dolomitic limestone was the only filler used. The amounts of each of the elements applied each crop year are presented in Table 1.

During the three crop years 1942-43 through 1944-45, the 8-0-8 mixture was used three times a year as follows: Fifty percent of the total poundage was applied in November or December, 30 percent in March or April, and 20 percent in May or June. Beginning with the 1945-46 crop year, this program was changed so that about 70 percent of the total annual supply of nitrogen was applied in the fall from ammonium nitrate, and no other fertilizer elements were applied at this time. The rest of the nitrogen and all of the annual dosage of the other major and minor elements were applied in two equal applications in spring and summer from a 5-0-18 mixture. Dolomitic limestone was applied to all plots at the rate of 1,200 lbs. per acre in March 1946 and 900 lbs. per acre in May 1948. The method of timing nitrogen and the ratio of nitrogen to potash in this experiment both diverge from common practices (4).

The differential phosphate treatments were applied separately by hand in three applications per year for the first three crop years and in only two applications during the last three crop years. Plots designated A received no phosphate at all. The B plots received approximately 1, the C plots 3, and the D plots 8 units of  $P_2O_5$  for each 4 units of nitrogen applied. This last ratio of phosphate to nitrogen approximates standard practice

in the majority of citrus growing sections of Florida. The phosphate source used was 20 percent superphosphate. This material contains approximately 50 percent of gypsum. Compensating amounts of gypsum were added to the other treatments so that all received approximately the same dosage as the high phosphate plots. No effort was made to compensate for the calcium supplied by the several calcium phosphate salts in super-

TABLE 1

SUMMARY OF FERTILIZER TREATMENTS APPLIED TO VALENCIA PHOSPHATE PLOTS

Fertilizer element	Crop Year <sup>1</sup>						
	1941-42 <sup>1</sup>	1942-43	1943-44	1944-45	1945-46	1946-47	1947-48
	(pounds/tree/year)						
<i>All plots</i>							
N	1.23	1.52	1.60	1.60	1.80	2.25	1.92
K <sub>2</sub> O	0.96	1.52	1.60	1.60	1.80	2.25	2.25
MgO <sup>2</sup>	N.R.	0.32	0.54	0.54	0.60	0.75	0.75
MnO	N.R.	0.12	0.14	0.20	0.20	0.25	0.25
CuO	N.R.	0.06	0.10	0.20	0.20	0.25	0.25
ZnO	N.R.	0.08	0.08	0.08	0.10	0.13	0.13
B <sub>2</sub> O <sub>3</sub>	N.R.	0.008	0.011	0.018	0.020	0.023	0.023
Fe <sub>2</sub> O <sub>3</sub>	N.R.	0.19	0.20	0.20	0.20	0.25	0.25
Dolomite	N.R.	1.0	5.3	4.3	13.6	0.9	8.7
<i>A plots</i>							
P <sub>2</sub> O <sub>5</sub>	0.0	0.05	0.0	0.0	0.0	0.0	0.0
CaSO <sub>4</sub>	1.29	6.48	9.60	9.60	9.60	11.2	11.2
<i>B plots</i>							
P <sub>2</sub> O <sub>5</sub>	0.07	0.38	0.48	0.48	0.48	0.56	0.56
CaSO <sub>4</sub>	1.13	5.67	8.40	8.40	8.40	10.2	10.2
<i>C plots</i>							
P <sub>2</sub> O <sub>5</sub>	0.19	1.02	1.44	1.44	1.44	1.68	1.68
CaSO <sub>4</sub>	0.80	4.05	6.00	6.00	6.00	7.00	7.00
<i>D plots</i>							
P <sub>2</sub> O <sub>5</sub>	0.48	2.64	3.84	3.84	3.84	4.46	4.46
CaSO <sub>4</sub>	0.00	0.00	0.00	0.00	0.00	0.00	0.00

<sup>1</sup> Differential treatments were started May 1942, but the crop year is considered to begin with the fall fertilizer application.

\* Water-soluble MgO.  
N.R.—No record.

phosphate. The amounts of  $P_2O_5$  and gypsum applied in the various treatments are presented in Table 1.

The trees appeared to be of normal vigor and density of foliage during the test period. An adequate pest control program was used throughout the experiment. Zinc and copper nutritional sprays were used in some years.

*Plan of Pineapple Experiment.* The second phosphate fertilizer experiment was established in a block of young Pineapple oranges on rough lemon stock. This grove was planted in March 1943 on a tract of virgin Lakeland sand cleared for the purpose and located near Tavares in Lake County. Twenty-four plots of 12 trees each were laid out with guard rows separating the plots. The planting distance is 20 x 30 feet. The random-block design used consists of 6 blocks of four plots each. The four fertilizer treatments in each block are essentially the same as those used in the Valencia experiment, and bear the same designations, but of course smaller quantities of fertilizer were used for these young trees. The differential phosphate treatments were begun in the spring of 1944, 1 year after the young trees were planted. During the first season after planting the young trees in all plots were fertilized with a total of about 5 pounds per tree of 8-0-8 mixture that contained about 0.4 percent of  $P_2O_5$  in the castor pomace, so that each tree received an initial application of about 0.02 lbs. of  $P_2O_5$ . After differential treatment began, all plots were fertilized three times per year with an 8-0-8 mixture containing 3 to 4 percent of soluble  $MgO$ , 2 percent of  $MnO$ , 1 percent of  $CuO$ , 0.1 percent of  $B_2O_3$ , and 100 to 200 pounds of dolomite filler. Organic nitrogen carriers, such as castor pomace or tobacco stems,

usually supplied from 8 to 15 percent of the nitrogen in the mixture and contributed a maximum of about 0.05 pounds of  $P_2O_5$  per tree per year to all plots. Currently 5 to 6 pounds of this mixture per tree are applied by machine at each application. The trees in all plots have made good to excellent growth since planting, and appear vigorous and healthy. None of the plots has been seriously injured by frost to date.

*Analytical Methods.* Leaves for analysis were scrubbed in a neutral detergent solution (sodium lauryl sulfate), rinsed repeatedly in distilled water, oven dried, weighed, and then ground to a fine powder. The chemical elements K, Ca, and Mg were determined on ashed portions of leaves and on fruit juice by rapid photometric methods adapted from those described by Peech and English (17). Phosphorus and nitrogen were determined by a slight modification of the methods described by Cotton (7). Zinc was determined by the AOAC method (1). The other trace elements and sodium were determined by spectrographic methods (8).

Soil samples were analyzed for exchangeable bases, water-soluble phosphorus, and acid-available phosphorus essentially by the methods of Peech et al. (18). Total phosphorus in the soil was determined in a suitable aliquot of an extract obtained by digesting 25 grams of soil for 1 hour with 30 ml. of a mixture of equal parts 6N HCl and 9N  $HNO_3$ .

Fruit samples were taken at various times during the ripening seasons of the two varieties. Thirty outside fruit were taken from each plot in a band 3 to 8 feet above the ground, so that the sides of the trees furnished fruit approximately in proportion to the density of the crop. The measurements of diameter and rind

thickness were made on each fruit after slicing into halves. The total soluble solids determinations were made with a Brix hydrometer prior to 1948, when a refractometer was used. The acidity was determined by titration with standardized NaOH and expressed as percentage of anhydrous citric acid. Ascorbic acid was measured by the AOAC method (1).

#### EXPERIMENTAL RESULTS

*Yield.* The effect of phosphate fertilization on yield of fruit in the Valencia experiment is summarized graphically in Fig. 1. It will be noted that there was no substantial difference in yield among the various treatments at the outset of the experiment (1942 harvest data) or during the first 3 years of differential treatment. The 1946 yield data (for the crop which was set in the spring of 1945, but harvested in May of 1946), when considered alone, indicate a highly significant increase in yield due to phosphate fertilization. However, the isolated 1947 data indicate a significant decrease in yield associated with phosphate fertilization. In 1948 this trend is again reversed, and the variation in yield due to treatment approaches high significance. The general increase in yield in 1948 appears to be due to the increase in fertilization beginning in the fall of 1946 (see Table 1). The grand annual yield means

for the six-year period of differential treatment are shown in table below.

The yield data from these plots during the six seasons of differential treatment were examined statistically by the analysis of variance method. These calculations indicate that the differences among the grand treatment means presented above are not significant; that is, the differences in total yield could be due to normal plot variation.

Examination of the data in Fig. 1 shows that beginning with the 1947 season, appreciable alternate bearing developed in certain of the treatments. The A and B plots had their light crop or "off" year in 1946, and their "on" year in 1947, while the reverse was true for the D plots. The D plots are currently leading in yield because of the two "on" years and one "off" year. Some factor, possibly the severe drought of the spring and early summer of 1945, seems to have caused a sharp accentuation of the alternate bearing tendencies already discernible in the 1943, 1944, and 1945 yield data. Whether the difference between the alternate bearing cycle of the A and B plots and that of the D plots is a real and significant effect of phosphate fertilization is not clear. The means of the yields of the five C plots show a remarkable absence of alternation, although there was decided alternate

<i>Treatments</i>	<i>Grand yield means per year</i>	
	<i>as pounds per tree</i>	<i>as boxes per acre</i>
A—No $P_2O_5$	251	307
B—Low $P_2O_5$	253	309
C—Med. $P_2O_5$	247	302
D—High $P_2O_5$	272	332

bearing among individual C plots during the six-year period; this suggests the possibility of a chance relationship. Perhaps yield data in subsequent seasons will shed additional light on this question.

Yield data were obtained from the Pineapple experiment in 1947 and 1948, the first two harvested crops. The mean yields per tree were as follows:

Treatment	Yield in pounds per tree for	
	1947 crop	1948 crop
A—No $P_2O_5$	35	91
B—Low $P_2O_5$	39	83
C—Med. $P_2O_5$	43	90
D—High $P_2O_5$	40	94

The 1948 harvest records were obtained after four years of differential treatment on five-year-old trees. It is apparent that there were no significant effects of treatment on yield in either year.

*Growth.* Trunk circumference measurements were made on the test trees at the outset of the Valencia experiment in 1942, and almost annually thereafter. The data obtained indicate that the medium and heavy phosphate treatments were associated with depressed growth as measured by the percentage increase in cross-sectional area of trunks. Similar data obtained from the Pineapple plots indicate no significant effect of treatment during the 1944-1947 period. These data are summarized in Table 2.

*Leaf Composition.* Leaf samples were collected from the Valencia plots in the midsummers of 1946 and 1947. About August 1 of each year single leaves were

harvested from four to six nonfruiting, spring-flush twigs distributed around each of the central eight trees in each plot, amounting to a total of 48 leaves per sample in 1946 and 32 leaves per sample in 1947. Spring-flush twigs supporting June-flush shoots were avoided, as were twigs with damaged or otherwise abnormal leaves. These leaves were between 4 and 5 months old at the time of harvest. The summaries of the analyses of these foliage samples are presented in Tables 3 and 4.

In both the 1946 and the 1947 leaf samples the effect of phosphorus fertilization was reflected in the phosphorus content of the leaves. The amount of phosphorus in the foliage from the high-phosphate plots was only 10 to 12 percent greater than that in the no-phosphate plots, but statistically this difference is highly significant. Contrary to evidence with many plants, phosphate fertilization did not depress significantly the nitrogen content of the foliage sampled in either year. There was no significant effect of treatment on the dry weight of the leaves sampled in either season, but the 1946 leaves were considerably heavier than the 1947 leaves. The latter were produced in a year when bloom was from 4 to 6 weeks later than normal.

In 1946 there was an indication of a depressing effect of heavy phosphate fertilization on the magnesium content of the foliage. A similar trend was apparent in the 1946 leaves, but was not of sufficient regularity to reach statistical significance. Recent observations (August 1948) reveal that there is a slight amount of magnesium deficiency symptoms in the heavy phosphate plots, but none in any of the other treatments. These analyses and observations suggest

that heavy phosphate fertilization may have induced slight magnesium stress, particularly in the heavy crop years of 1946 and 1948.

There was no effect of phosphate fertilization on either the potassium or the calcium content of the foliage in 1946. In 1947 phosphate fertilization increased the calcium content of the foliage slightly, but not significantly, and, as would be expected, there was a parallel decrease in potash content.

No data on the trace element concentrations are available for the 1946 season, but the data for the 1947 foliage samples presented in Table 4 indicate that phos-

phate fertilization increased zinc and manganese in the foliage, but decreased copper. The magnitude of these effects of treatment is greater than those for the major elements. There appears to be no significant effect of treatment on the boron, iron, or sodium content of the foliage.

Spring flush leaves were collected in July 1947 from the Pineapple plots and analyzed for the same elements as the Valencia leaf samples. These data indicated that none of the differences among the treatment means was sufficiently large to be significant. However, the trends for potassium, calcium, and mag-

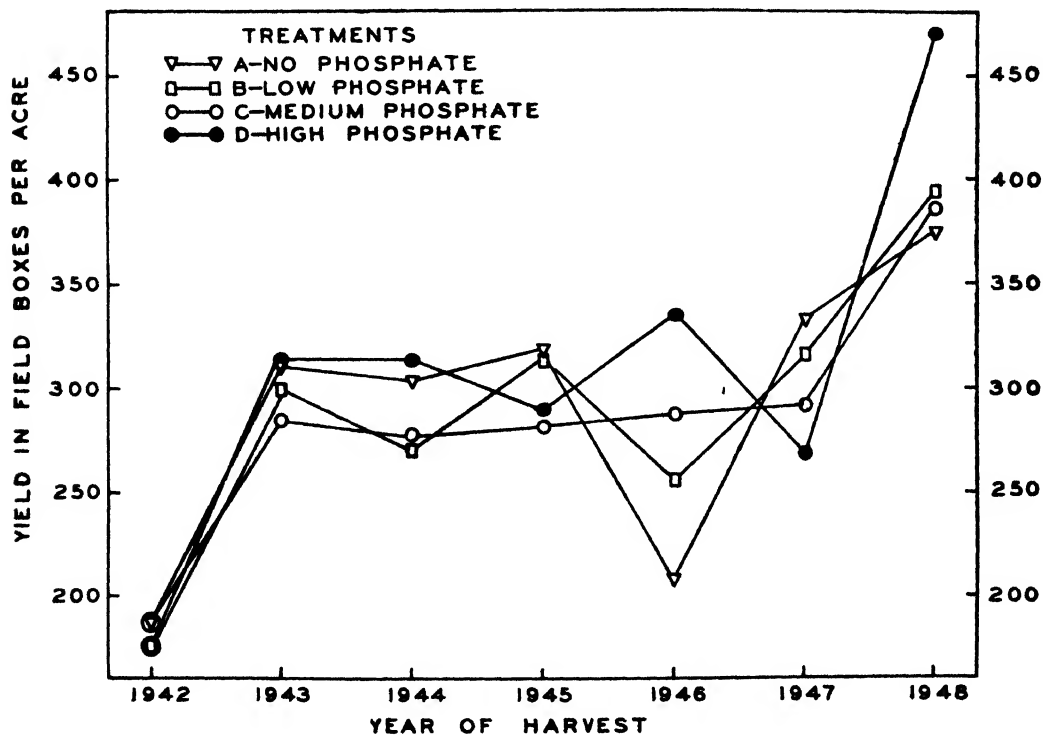


Figure 1. A graphic presentation of the yield data in field boxes per acre from the Valencia experiment during the period from 1942 through 1948.

TABLE 2

THE EFFECT OF PHOSPHATE FERTILIZATION ON THE INCREMENT IN CROSS-SECTIONAL  
AREA OF TRUNK OF ORANGE TREES

Treatment	Valencia plots			Pineapple plots		
	Mean x-sec. cm <sup>2</sup>	Mean x-sec. cm <sup>2</sup>	Percent increase	Mean x-sec. cm <sup>2</sup>	Mean x-sec. cm <sup>2</sup>	Percent increase
	1942	1948		1944	1947	
A—No P <sub>2</sub> O <sub>5</sub>	298.6	382.5	28.2	8.4	52.8	526
B—Low P <sub>2</sub> O <sub>5</sub>	279.4	354.3	26.9	8.4	49.7	492
C—Med. P <sub>2</sub> O <sub>5</sub>	266.4	329.7	23.8	8.3	52.6	531
D—High P <sub>2</sub> O <sub>5</sub>	287.4	355.9	23.9	7.9	49.3	515
Effect of treatment	N.S.	*	*	N.S.	N.S.	N.S.
L.D. at .05	—	31.2	3.5	—	—	—

Statistical symbols:

\* = Significant (F value between 0.05 and 0.01 level).

N.S. = Not significant.

L.D. = Least difference for significance between any two means

TABLE 3

SUMMARY OF ANALYSES OF FOLIAGE FROM THE VALENCIA EXPERIMENT  
1946 AND 1947 SEASONS

Treatment and statistical indices	Mean dry wt per leaf mg.	Mean percentage in dry matter				
		N	P	K	Ca	Mg
1946 Season						
A—No P <sub>2</sub> O <sub>5</sub>	400	2.80	0.142	1.66	3.70	0.400
B—Low P <sub>2</sub> O <sub>5</sub>	380	2.64	0.150	1.58	3.56	0.390
C—Med. P <sub>2</sub> O <sub>5</sub>	398	2.70	0.150	1.68	3.76	0.350
D—High P <sub>2</sub> O <sub>5</sub>	376	2.68	0.156	1.68	3.64	0.332
Effect of treatment	N.S.	N.S.	••	N.S.	N.S.	•
L.D. at .05	—	—	0.006	—	—	0.046
L.D. at .01	—	—	0.009	—	—	0.064
1947 Season						
A—No P <sub>2</sub> O <sub>5</sub>	276	2.82	0.136	1.72	3.06	0.350
B—Low P <sub>2</sub> O <sub>5</sub>	272	2.84	0.143	1.70	3.16	0.358
C—Med. P <sub>2</sub> O <sub>5</sub>	274	2.86	0.145	1.70	3.22	0.344
D—High P <sub>2</sub> O <sub>5</sub>	298	2.82	0.152	1.52	3.76	0.332
Effect of treatment	N.S.	N.S.	••	•	••	N.S.
L.D. at .05	—	—	0.007	0.15	0.30	—
L.D. at .01	—	—	0.010	0.21	0.42	—

Statistical symbols.

N.S. = Not significant.

\* = Significant (F value between 0.05 and 0.01).

\*\* = Highly significant (F value above 0.01 level)

L.D. = Least difference for significance between any two means.



TABLE 4  
SUMMARY OF TRACE ELEMENT ANALYSES OF FOLIAGE FROM THE VALENCIA EXPERIMENT  
1947 SEASON

Treatments and statistical indices	Mean p.p.m. in dry matter					
	Zn	Mn	Cu	B	Fe	Na
A—No $P_2O_5$	24.4	38.6	9.4	152	60.9	462
B—Low $P_2O_5$	25.8	41.1	8.9	158	58.9	461
C—Med. $P_2O_5$	36.0	46.0	8.4	143	59.2	491
D—High $P_2O_5$	10.8	52.3	7.2	140	57.6	467
Effect of treatment	**	**	**	N.S.	N.S.	N.S.
L.D. at .05	3.3	5.0	1.1	—	—	—
L.D. at .01	4.6	7.0	1.6	—	—	—

Statistical symbols:

\*\* = Highly significant (F value above 0.01 level).

N.S. = Not significant.

L.D. = Least difference for significance between any two means.

nesium were in the same direction as those in the Valencia plots, and possibly foreshadow differences to come.

**Soil Composition.** Initially, the exchangeable bases and the exchange capacity of the soil (Table 5) in the Valencia plot area approximated, in most respects, the mean levels found by Peech (15) in Norfolk-type citrus soils surveyed in 1937. However, the exchangeable magnesium level was considerably above average. This may be due to the fact that Peech's samples were obtained before the regular use of magnesium materials in citrus fertilization had gained such momentum. The initial dilute acid soluble and the water-soluble phosphorus levels were below the average values found by Peech (15). Likewise, the initial total phosphorus values (Table 6) of around 800 pounds per acre-foot in the plot area is also below average for citrus grove soils of this type (20). No doubt this is a reflection of the sparing use of phosphatic fertilizer

materials in this grove in the period before the experiment was established.

By 1945 the effect of differential treatment on the phosphate status was evident. It appears that water-soluble phosphorus was more closely related to the rate of phosphate fertilization than was acid-available phosphorus.

In April 1942 a series of top-foot soil samples was obtained from the Valencia plots before differential treatment began, and a similar set of samples was obtained in November 1946. The phosphorus and the calcium status of these two sets of samples is presented in Table 6. In spite of considerable variability, the effect of treatment on the phosphorus status in 1946 was highly significant. Again the water-soluble phosphorus was more closely correlated with treatment than acid-available phosphorus. The pH data (not presented) and the exchangeable calcium figures suggest that the high-phosphorus plots were slightly more acid than the check plots, but the differences

TABLE 5  
THE EXCHANGEABLE BASE AND THE PHOSPHORUS STATUS OF THE TOP 6 INCHES OF  
SOIL IN THE VALENCIA PLOTS

Treatments	pH of mean acidity	Mean base exchange capacity		Mean lbs. per acre-six-inches <sup>1</sup>			H <sub>2</sub> O- soluble P
		m.e./100 gr.	Ca	Exchangeable K	Mg	Acid- soluble P <sup>2</sup>	
<i>Samples collected Sept. 1942</i>							
A—No P <sub>2</sub> O <sub>5</sub>	6.0	2.63	590	83	88	171	5.6
B—Low P <sub>2</sub> O <sub>5</sub>	6.0	2.34	520	80	75	181	5.3
C—Med. P <sub>2</sub> O <sub>5</sub>	5.9	2.33	542	82	80	181	5.4
D—High P <sub>2</sub> O <sub>5</sub>	6.0	2.42	572	92	89	156	4.5
<i>Samples collected Sept. 1945</i>							
A - No P <sub>2</sub> O <sub>5</sub>	6.0	2.32	602	60	92	178	3.6
B—Low P <sub>2</sub> O <sub>5</sub>	6.0	2.13	560	70	94	195	6.1 <sup>*</sup>
C—Med. P <sub>2</sub> O <sub>5</sub>	5.9	2.34	599	60	88	215 <sup>1</sup>	9.3 <sup>*</sup>
D—High P <sub>2</sub> O <sub>5</sub>	5.8	2.42	624	61	80	251 <sup>2</sup>	16.3 <sup>*</sup>

<sup>1</sup> The top 6 inches was assumed to weight 2,000,000 pounds per acre.

<sup>2</sup> To convert P to P<sub>2</sub>O<sub>5</sub>, multiply by the factor 2.29.

<sup>3</sup> These means differ from the A treatment means by statistical odd greater than 19:1 but less than 99:1.

<sup>4</sup> These differ from A treatment means by odds greater than 99:1.

were not of sufficient magnitude to be significant statistically. The same trend is suggested by the data in Table 5. In spite of this trend, the leaf analysis data (Table 3) show the presence of more calcium in foliage of the high-phosphorus plots in 1947. A similar trend is suggested by the leaf analysis data from the Pineapple plots. This raises the question as to whether calcium in the form of calcium phosphate adds to the supply of available calcium in the soil, or whether high phosphate-ion concentration in some way increases the accumulation of calcium in the leaves of the plant.

The data concerning the phosphorus status of the soil from the Pineapple plots show essentially the same trends as those indicated in Table 6. The initial total

phosphorus level in this virgin soil was about 300 lbs. per acre-six-inches, which appears to be below average for this soil (20). After 4 years of phosphate fertilization, the heavy phosphate plots contained about 560 pounds of total phosphorus per acre-six-inches, an increase of 260 pounds per acre. The amount applied was only about 140 pounds when calculated on an acre basis. However, the material was applied by hand and distributed more heavily in the region about the tree where the soil samples were obtained. As in the Valencia plot data, the water-soluble phosphorus content of soil samples from the various treatments is more closely correlated with the amount of phosphate applied than is the acid-available phosphorus

TABLE 6  
THE EFFECT OF PHOSPHORUS FERTILIZATION ON THE PHOSPHORUS STATUS OF THE TOP FOOT OF SOIL IN THE VALENCIA PLOTS

Treatment	1942 Samples				1946 Samples				Total P mean gain '42-'46	Total P applied '42-'46
	Mean		Mean P		Mean		Mean P			
	exch.	Ca	Acid- soluble	H <sub>2</sub> O- soluble	exch.	Ca	Acid- soluble	H <sub>2</sub> O- soluble		
	(pounds, per acre-foot <sup>1</sup> )									
A-No P <sub>2</sub> O <sub>5</sub>	760		302	10.0		801	268	4.4	73	0
B-Low P <sub>2</sub> O <sub>5</sub>	644		342	9.2		748	260	5.6	136	87
C-Med. P <sub>2</sub> O <sub>5</sub>	688		248	10.8		806	288	14.4	196	241
D-High P <sub>2</sub> O <sub>5</sub>	712		236	10.0		696	388	23.0	577	639
Effect of treatment	N.S.		N.S.	N.S.		N.S.	•	••	••	—
L.D. at .05 level	—		—	—		—	87	2.0	200	—

<sup>1</sup> An acre-foot was assumed to weigh 4,000,000 lbs. To convert P to P<sub>2</sub>O<sub>5</sub>, multiply by the factor 2.29.

Statistical symbols:

N.S. = Not significant.

• = Significant (F value between .05 and 0.01 level)

•• = Highly significant (F value above 0.01 level).

L.D. = Least difference for significance between any two means.

content. There was no significant difference in the acidity of the plots after 4 years of differential phosphate fertilization.

*Fruit Composition.* Samples from the Valencia plots were analyzed twice in 1947, and three times in 1948. The results for the March samplings of each year are presented in Table 7.

The mean fruit diameter did not differ significantly among treatments either year, although there was a tendency for fruit size to be related to amount of crop in the various treatments. Thus, 1947 being a heavy crop year for the low-phosphorus plots, slightly smaller fruit resulted than in the high-phosphate plots which had a relatively light crop that year. Since the bearing behavior was reversed in 1948, the fruit tended to be larger in the low-phosphate plots. The thickness of rind tended to vary in direct relation to fruit size, inversely to crop size, and was not directly related to treatment.

There was no difference between phosphate treatments in percentage of juice in 1947, but there was a trend toward higher juice content in relation to increased phosphate fertilization in 1948. It seems probable that this is a function of fruit size, and the relation to fertilization is incidental.

In both the 1947 and the 1948 crops there was a significant difference in the total soluble solids of the juice in relation to treatment. The results each year indicate a lowering of soluble solids with increased phosphate fertilization. The magnitude (3 to 7 percent reduction) of this effect was not great, but was consistently found in all samplings. A similar response by grapefruit to superphosphate on phosphorus-deficient soil in Jamaica was found by Innes (11). The

data of Forsee and Neller (10), working with oranges on organic soil in the Everglades of Florida, also suggest that above the deficiency level increased phosphate fertilization reduces solids.

The citric acid content was decidedly less in all treatments in the 1948 season than in the 1947 season. This may be a seasonal effect, as the only change in fertilization during this time was an increase in the total amount of fertilizer applied. Among treatments, there was also a significant lowering of acid in the highest phosphate treatment.

The ratio of total soluble solids to citric acid was lower in 1947 than in 1948, but it did not show a significant relationship to the differential treatments when sampled in March.

The constituent that showed the greatest difference due to treatment was ascorbic acid (vitamin C). The five sets of determinations made in 1947 and 1948 showed a mean difference of 14.6 percent less ascorbic acid in the high-phosphate treatment in comparison with the low. Statistically, this difference is highly significant. In 1948 this same magnitude of difference was found in the samplings of January, March, and May. That grapefruit may respond in the same way is suggested by the work of Innes (11), where the overcoming of phosphorus deficiency was accompanied by a decrease in ascorbic acid in the fruit. Also, Jones and Parker (14), working with Navel oranges in California, have shown that phosphorus fertilization depressed vitamin C, total soluble solids, and acid in the juice.

The nitrogen content of the juice was found to be significantly greater in the highest phosphate treatment both in 1947 and in 1948. The amounts of calcium, magnesium, and potassium in the

TABLE 7  
SUMMARY OF FRUIT QUALITY MEASUREMENTS MADE IN MARCH FOR THE YEARS 1947, AND 1948 FOR THE VALENCIA PLOTS

Measurement	Phosphate Treatment				L.S.D. <sup>1</sup>	
	None	Low	Med.	High	0.05	0.01
<i>March 26, 1947 sampling</i>						
Fruit wt. (gm.)	220.8	225.0	223.0	228.8	—	—
Rind thickness (mm.)	3.8	3.8	3.8	4.1	—	—
Percentage of juice	51.3	50.9	51.8	50.7	—	—
Percentage of total soluble solids	10.96	10.86	10.82	10.64 <sup>2</sup>	0.29	—
Percentage of citric acid (by wt.)	1.31	1.26	1.27	1.29	—	—
T.S.S.	—	—	—	—	—	—
Ratio $\frac{\text{C.A.}}{\text{C.A.}}$	8.4	8.6	8.7	8.3	—	—
Ascorbic acid (mg. per 100 ml. juice)	40.7	38.9 <sup>2</sup>	36.9	33.6 <sup>2</sup>	1.4	2.0
Phosphorus (p.p.m. P in juice)	161	160	177	185 <sup>2</sup>	5.7	8.0
Nitrogen (p.p.m. N in juice)	966	947	988	1040 <sup>2</sup>	59.0	—
<i>March 17, 1948 sampling</i>						
Fruit wt. (gm.)	228.4	220.0	221.2	218.0	—	—
Rind thickness (mm.)	4.6	4.3 <sup>2</sup>	4.3 <sup>2</sup>	4.1	0.23	0.32
Percentage of juice	54.0	54.8	54.9	56.1	—	—
Percentage of total soluble solids	10.18	10.26	9.86	9.48	0.40	0.56
Percentage of citric acid (by wt.)	0.98	1.00	0.95	0.93 <sup>2</sup>	0.058	—
T.S.S.	—	—	—	—	—	—
Ratio $\frac{\text{C.A.}}{\text{C.A.}}$	10.4	10.3	10.4	10.2	—	—
Ascorbic acid (mg. per 100 ml. juice)	44.3	44.1	42.3	38.3	1.6	2.2
Phosphorus (p.p.m. P in juice)	140	144	145	152	—	—
Nitrogen (p.p.m. N in juice)	752	772	792 <sup>2</sup>	814 <sup>2</sup>	32.2	—
Potassium (p.p.m. K in juice)	1490	1536	1426	1418	—	—
Magnesium (p.p.m. Mg in juice)	109	112	107	106	—	—
Calcium (p.p.m. Ca in juice)	73	70	73	73	—	—

<sup>1</sup> Least difference required for significance between any two means.

<sup>2</sup> Denotes statistical significance between 0.05 and 0.01 level when compared to the no phosphate treatment.

<sup>3</sup> Denotes statistical significance exceeding the 0.01 level.

juice showed no significant differences among treatments.

Fruit samples from the Pineapple plots were analyzed twice during each of the 1946-47 and 1947-48 harvesting seasons. There were no differences that could be attributed to the differential phosphate fertilization, and therefore no data are presented for these measurements.

### DISCUSSION

The results obtained in these experiments to date indicate that heavy superphosphate fertilization did not improve tree growth or fruit production in the two test plots of oranges located on acid sandy soil. The question may be raised as to whether any of the superphosphate applied was beneficially used by the experimental trees. A similar question was raised more than 30 years ago by Collison and Walker (5) as a result of studies with citrus trees growing in lysimeter tanks. The fact that the young Pineapple trees, growing in the no-phosphate plots for 5 years, have developed and fruited in a normal manner on a maximum of about 0.05 pounds per tree per year of added  $P_2O_5$  (present in organic N sources) indicates that so far this amount, together with the native supply in the soil, has been adequate to satisfy the requirements of these trees. It seems probable, however, that the trees will eventually show phosphorus stress. An estimate based on analyses given in the literature (23) and upon the assumption that 100 pounds of dry weight of new tree growth plus 200 pounds of fresh weight of fruit were produced by these 5-year-old trees, indicates that the net amount of  $P_2O_5$  removed from the soil during the first 5 years amounted to less than 0.5 pound per tree.

These results appear to agree roughly with Veerhoff's (22) findings that only relatively small amounts of phosphate fertilizer could be used beneficially by peach trees. He established a phosphate fertilizer experiment with peaches in the Sandhills section of North Carolina on virgin soil classified as Norfolk-sand. This soil is evidently similar in texture and morphology to the Lakeland series (formerly called Norfolk series) of soils which are common in the Florida citrus belt and on which both of the present citrus fertilizer experiments are located. Although Veerhoff found a definite response of the cover crop to phosphate fertilization, none has so far been noted by inspection of the cover crop (mostly volunteer grasses) in either the Valencia or the Pineapple plots.

The single-strength superphosphate used in these experiments is generally used as the source of phosphorus in the mixed fertilizers applied to citrus in Florida. About one-half of this material is gypsum. Appropriate gypsum supplements were added to all but the high-phosphate plots to maintain the added calcium sulfate at the same level in all treatments. Had some other phosphatic material, such as triple superphosphate, been used, so that little gypsum was applied to any of the plots, it is conceivable that the results of these experiments would have been different. This seems unlikely, however, since fairly large amounts of calcium were supplied to all plots in the form of dolomitic limestone (see Table 1).

The soil analyses for total phosphorus presented confirm the findings of others (2, 5, 6, 15, 20) that phosphates accumulate in Florida soils. The dilute acid-soluble and the water-soluble phosphorus data, together with the leaf

analysis data, suggest that this accumulation is associated with increased availability to orange trees.

Two of the outstanding effects of heavy phosphate fertilization on leaf composition were the depression of copper content and the increase in zinc and manganese. No data are available for these elements on the 1946 samples, when crop size in relation to treatment was the reverse of the 1947 season. The possibility that these effects are simply due to crop size should not be overlooked. However, the copper data seem to conform with the results reported by Forsee and Neller (10), who noted that heavy superphosphate fertilization of orange trees on organic soil induced ammoniation, which is probably due to a deficiency of copper (3). Both Peech (16) and Jamison (12, 13) seem to agree that adding moderate amounts of phosphate does not increase the fixation of copper by Florida soils, as measured by extraction with salt solutions or with water. Thus it appears either that exchangeable or water-soluble copper is not a good measure of the availability of copper in the soil, or that phosphate ion or some other constituent of superphosphate reduces the accumulation of copper in the leaves by some mechanism such as antagonism. Similarly, heavy superphosphate fertilization must either increase zinc and manganese availability in the soil, or in some way condition the plant to accumulate more zinc and manganese in its foliage. In view of the fairly large amounts of soluble zinc and manganese applied uniformly to all plots each year, it seems unlikely that the amounts of zinc and manganese 0.1 to 0.5 percent present in superphosphate (9) could account for the magnitude of difference found.

The increased application of phosphate tended to reduce the internal quality of fruit from these plots. The differences found probably would not be detectable by taste; however, such a reduction in the ascorbic acid could be an appreciable economic factor since, at the present time, fruit that is used for canning must have a certain ascorbic acid content to make U. S. Grade A juice. Valencia oranges sometimes fail to meet this requirement in the latter part of the season.

These fertilizer experiments with citrus illustrate the limitations of a moderate-sized random-block plot design with five or six replications. With the mature bearing trees of the Valencia plots, the yield variance was such that from 11 to 15 percent difference in yield was required for statistical significance (.05 level) in any given year. In the case of the young trees just coming into bearing in the Pineapple plots, the error term for the 1948 yield data was such as to require a least difference of around 22 percent for significance between any two treatment means. It is anticipated that as these young trees mature, yield variability will decrease. If these two locations are indicative of the normal yield variability found in reasonably uniform citrus plantings on this common soil type, more elaborate plot techniques will be required to evaluate with certainty and precision relatively small yield effects due to fertilizer treatments.

#### SUMMARY

This paper is concerned with the results obtained from two field experiments with oranges on the acid, sandy soils of Florida. Three levels of superphosphate fertilization and no-phosphate treatment are compared in a mature Valencia

orange grove and in a young Pineapple orange grove, the latter planted on virgin soil. Yield and growth data are evaluated for a six-year period in the Valencia experiment, and for a four-year period in the Pineapple experiment. In addition, certain effects of treatment on foliage, soil, and fruit composition are presented.

The results obtained to date indicate that no beneficial use was made of the superphosphate applied to the orange trees in the two experimental blocks. No significant effect on total yield was produced by any of the phosphate levels in either of the two experiments. There was an indication of a depression in growth associated with heavy superphosphate application as measured by the percentage increase in trunk cross-section in the Valencia, but not in the Pineapple experiment.

Analysis of foliage samples indicates that heavy phosphate fertilization was associated with increased accumulation of phosphate, zinc, and manganese and decreased accumulation of copper in the leaves. There was no significant effect of treatment on the nitrogen, sodium, boron, or iron content of foliage. There is a suggestion that the heavy phosphate fertilization decreased magnesium and potash and increased calcium in the foliage.

Analysis of soil samples from the plots indicates that water-soluble phosphorus reflected with considerable accuracy the rate of phosphate application, but dilute acid-soluble phosphorus was not so closely related to rate of application. Most of the applied phosphate could be accounted for in the topsoil by analysis for total phosphorus. There were no major effects of treatment on soil acidity

or on exchangeable calcium, potassium, or magnesium content.

In 1947 and 1948 the fruit produced by the Valencia plots showed that with increased amounts of applied phosphate, total soluble solids, citric acid, and ascorbic acid in the juice were lowered somewhat and phosphorus and nitrogen in the juice were increased slightly. No significant effect of treatment on fruit composition was found in the Pineapple plots.

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# CITRUS PRODUCTION PROBLEMS

HOWARD A. THULLBERY

The topic assigned me is "Citrus Production Problems" and since all production problems today revolve more or less around production costs, I shall discuss production costs.

During the 1945-46 fruit season, the citrus growers of Florida were little concerned about production costs. In the season of 1946-47 they became quite production-cost-conscious and since that time have steadily become more so.

We felt, back in 1945-46, that the time would come when this would be true, and at that time selected at random what we considered were 33 representative groves of the Haines City Citrus Growers Association. These groves var-

ied in size from 5 to 105 acres each. The acreage totaled 554 acres with 30.4 percent of the trees being grapefruit. The trees were from 20 to 35 years of age.

The costs were kept for the season beginning August 1st and running to July 31st of the season the crop was marketed.

These groves were entirely under our supervision. The association furnished all supplies and did all the work. This enabled us to keep accurate records of all moneys spent and allowed us to arrive at accurate production costs.

We maintained then, following a program designed to produce quantity and quality fruit, and are still of the opinion that anything cut from the program in the care of citrus, that is needed to pro-

COMPARATIVE PRODUCTION COSTS

	1945-46	1946-47	1947-48
Number of groves	33	33	33
Number of acres	554	554	548
Number of boxes	211,071	219,026	263,679
Boxes per acre	381	395	481
Percent trees grapefruit	30.4	30.4	30.4
Costs per acre	\$138.30	\$168.67	\$137.71
Costs per Box:			
Firing	.008	.025	.016
Irrigation	.017	.025	.008
Spraying and dusting	.062	.060	.042
Spray materials	.052	.051	.039
Cultivation	.011	.011	.009
Pruning	.023	.027	.024
Fertilizing	.010	.009	.006
Fertilizer and amendments	.173	.183	.120
Hauling—truck	.005	.004	.005
Miscellaneous	.002	.032	.017
Total	.363	.427	.286

duce quantity and quality fruit, will in the end cost rather than save the grower money.

Let us review the chart showing these costs over the seasons 1945-46, 1946-47, and 1947-48. (See page 61.)

You will notice the acreage dropped the third season from 554 to 548 acres. This was due to 6 acres of one grove being sold.

The production for the season 1945-46 was 211,071 boxes, increasing to 219,026 boxes in 1946-47 and 263,679 boxes in 1947-48, or an average yield of 381 boxes, and 481 boxes per acre for the three seasons.

The costs over the three seasons were \$138.30, \$168.67, and \$137.71 per acre.

In commenting on the breakdown of the per box costs, we would point out that only 163 acres of the 554 were fired, although this cost is spread over all fruit on the 554 acres. Likewise only a portion of the groves were irrigated.

Regarding the items of spraying and dusting, and spray and dust materials, we would call your attention to the fact that for the season 1947-48 dusts were applied throughout the year with the exception of the melanose and oil sprays, while for the first two seasons dusting was practiced only during the time all spraying machines were busy applying the oil spray applications. All groves received an oil spray yearly.

The pruning costs ran \$.023, \$.027, and \$.024 per box. On the acreage basis you can readily see that more money was spent on this item in the 1947-48 season than any other year. This was due, first, to the heavy scale infestations of the 1945-46 and 1946-47 seasons and second, to the fact that many of the groves were lifted and some hedged the past season in order that

they might be more easily cultivated and sprayed.

The fertilizer and amendments cost shows a considerable decrease in the 1947-48 season, dropping from around \$.18 per box to \$.12 per box. Aside from the increased production this was due to a cut in total units of plant food and a more economical mixture being applied.

Under the miscellaneous costs you notice a sharp increase for the 1946-47 and the 1947-48 seasons. This is due to the replacement of dead or missing trees and their care in these years. During the war we had neither the trees nor the labor to make these replacements.

The total box costs for the three seasons were \$.363, \$.427, and \$.286 respectively.

The lowest box cost we had the past season was on a 5-acre grapefruit grove which was \$.12 per box. The production was 915 boxes per acre and the per acre cost was \$109.47. On a 10-acre block, one-half grapefruit and one-half oranges, the cost was \$.172 per box with a production of 789 boxes per acre and an acre cost of \$136.20. On a 5-acre block, 80 percent oranges, the cost was \$.232 per box with 573 boxes per acre and an acreage cost of \$136.20. The highest per box cost was \$.516 on a grove 80 percent oranges that was both fired and irrigated and had an acreage cost of \$148.11 and a production of 292 boxes per acre. The highest acre cost was \$199.08 with a per box cost of \$.244 and production of 813 boxes per acre. 64 percent of the trees were grapefruit.

The past season showed a decrease in the per acre cost of \$30.96 or 18.4 percent from the 1946-47 season. However, our per box cost was \$.141 less or a decrease of 33 percent.

This means that 56 percent of the 33 percent decrease in the per box cost was due to spending less money on the groves and 44 percent of the decrease was due to increased production.

Putting it another way, had the production in 1947-48 been the same as in 1946-47, the per box cost would have been approximately \$.35 instead of \$.286.

While I believe we should do everything possible to improve quality, we must have production if we are to keep production costs down. Furthermore, I believe a heavy set of fruit is the number one requisite of a quality crop. You can't expect quality on a light crop of Valencia oranges regardless of what program you follow. I can't go along with the fellow that says he wants to grow less and better fruit.

We have pointed out the lower spraying and dusting costs of the 1947-48 season. We believe a saving can be made by dusting rather than spraying, except for the melanose and oil sprays, and the quality maintained, provided proper equipment is used. We would hesitate to follow a dust program unless a California-type duster or a helicopter were available and proper speed maintained. However, research is being done on different type dusters and suitable

equipment may soon be available.

Another important factor in low cost production is proper management of labor and equipment. Work should be planned well in advance so as to cut delays between operations to a minimum. Labor should be trained for the job they are to do and properly supervised. The equipment they use should be good and kept in good repair if production costs are to be kept down.

In summary, we believe it to be economical to use that program which will give us the largest quantity of the best quality fruit. That anything omitted from the program that the grove needs to gain this end will, in the long run, cost rather than save the grower money.

We believe that the number one requisite of quality, especially on Valencia oranges, is heavy production and that it is a major factor in low box costs.

Other factors tending to lower costs are economical fertilizer mixtures, dusting a part of the year, provided proper equipment is available, and proper management of labor and equipment.

Acknowledgment is made to the Haines City Citrus Growers Association for use of data used in this paper. Also to Professor L. W. Zeigler and W. L. Tait for compilation of same.

## A METHOD OF MAINTAINING VIABILITY OF CITRUS SEED IN STORAGE<sup>1</sup>

The storage of citrus seeds for extended periods, as is frequently necessary in shipment over long distances or when planting time is delayed for one reason or another, is usually attended by a serious reduction in viability. Considering the importance of the problem, there is surprisingly little information available in the literature on storing citrus seed in viable condition for prolonged periods. With the exception of L. V. Barton's<sup>2</sup> work, information is largely confined to rule-of-thumb recommendations such as to store the seeds in charcoal or in damp sand, or to store the fruits under refrigeration and extract the seeds when needed. Although such methods may be satisfactory for storing citrus seed for several weeks, germinability deteriorates seriously with storage for 6 months or more. In view of the scarcity of information on the subject and the success attained in some storage trials at Orlando, Florida, it was decided to publish the data available.

Preliminary experiments indicated that when citrus seeds were allowed to dry out viability was impaired. On the other hand, if storage was attempted with seeds in a moist condition the growth of fungi and bacteria soon destroyed viability. In order to find a suitable disinfectant for citrus seed to overcome this difficulty, ten fungicides were selected

lowers:] Fermate (ferric dimethyl dithiocarbamate), HE-175 (disodium ethylene bisdithiocarbamate), Phygon (dichloro for trial from materials at hand, as fol-napthoquinone), Semesan (hydroxy-mercurichlorophenol), DuPont 1155HH (DuPont Semesan Co. code number), 8-hydroxyquinoline sulfate, Puratized N5E (phenylmercuritriethanol ammonium lactate), ethanol, thiourea, and thiocyno aniline.

*Tests with Seed Disinfectants.* The first five materials listed above were applied in dust form to freshly extracted Duncan grapefruit seeds that had been washed to remove juice and mucilaginous materials and then dried on paper towels. The seeds, with an excess of the fungicidal dust, were shaken together in a beaker. Afterwards the seeds were picked up with tweezers, shaken gently to remove excess dust, and transferred to petri dishes containing potato dextrose agar. The last five fungicides were applied by momentarily dipping the seeds into a solution or suspension of the material. The seeds were drained dry on paper towels before being transferred to agar plates. In three weeks' time no fungus or bacterial growth appeared on the seeds treated with Semesan, DuPont 1155HH, 8-hydroxyquinoline sulfate, Puratized N5E, or thiocyno aniline (Table 1).

*Effect of Disinfectants on Viability.* In use, many seed disinfectants are quite specific in toxic effect. Some are safe for the treatment of the seed of certain species of plants and are injurious to

<sup>1</sup>Authors: James F. L. Childs, pathologist and Gustave Hrniciar, scientific aid, Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture.

<sup>2</sup>Barton, L. V. The storage of citrus seeds. Contr. Boyce Thompson Inst. 13(2): 47-55, 1943.

the seeds of other species. In order to investigate their possible toxic action and injury to germination, the five most efficient disinfectants in the above trial were used in the following experiment: Lots of 20 freshly extracted Sampson tangelo seeds, washed and surface-dried as before, were treated with (a) Semesan dust, (b) DuPont 1155HH dust, (c) 1.0 percent solution of 8-hydroxyquinoline sulfate, (d) .05 percent (by volume) solution of Puratized N5E, and (e) 1.0 percent solution of thiocyno aniline.

After treatment the seeds were germinated in damp cypress wood sawdust at 80°F. Three of the materials, c, d, and e, were found to be without adverse effect on germination (Table 2). Germination of the Semesan-treated seed was seriously impaired, and DuPont 1155HH stopped germination completely.

In another experiment Semesan and 8-hydroxyquinoline sulfate were compared on Duncan grapefruit seed at several levels of moisture content. The moisture

TABLE 1

A COMPARISON OF FUNGICIDES AS SURFACE-DISINFECTING AGENTS FOR CITRUS SEED

Material	Nature of surface contaminant	
	Bacteria	Fungi
1. Fermate, dust	0	+
2. HE-175, dust	+	0
3. Phygon, dust	+	0
4. Semesan, dust	0	0
5. DuPont 1155HH, dust	0	0
6. 8-hydroxyquinoline sulfate 1.0%, dip	0	0
7. Puratized N5E .05% (by volume), dip	0	0
8. Ethanol 70%, dip	+	0
9. Thiourea 5%, dip	+	0
10. Thiocyno aniline, 1.0%, dip	0	0
11. Check	+	+
12. Check	+	+

TABLE 2

EFFECT OF SURFACE DISINFECTION ON GERMINATION OF CITRUS SEED

Material	Germination in percent
1. Semesan	20
2. DuPont 1155HH	0
3. 8-Hydroxyquinoline sulfate 1.0%, dip	100
4. Puratized N5E .05% (by volume), dip	100
5. Thiocyno aniline 1.0%, dip	100
6. Check	100
7. Check	100

content of the seed was varied by the following pre-treatments: (a) soaked in water 4 hours to establish maximum content of water, (b) air-dried 4 hours, (c) air-dried 24 hours, and (d) air-dried 3 days. Lots of 60 seed each from the various treatments were then stored in cellophane bags for 1 month at a mean temperature of 70°F. Upon germinating the seed it was found that viability of seed in contact with Semesan became lower as the moisture content was increased (Table 3). The viability of untreated seed was decreased somewhat at the lowest moisture level.

*Effect of Moisture on Viability.* The effects of the moisture factor was investigated more fully in the following experiment. Freshly extracted Duncan grapefruit seeds, treated with Fermate and untreated, were stored at nine levels of relative humidity at room temperature for 2, 4, and 8 weeks. The several humidity levels were maintained over different concentrations of sulfuric acid in desiccator jars. After storage for the period indicated the seeds were germinated in moist sawdust. At the lowest humidity levels germinability of the seed decreased rapidly with increased time of stor-

TABLE 3  
RELATIVE GERMINATION OF DUNCAN GRAPEFRUIT SEEDS STORED ONE MONTH IN CELLOPHANE BAGS AT 70°F. THE SEEDS WERE BROUGHT TO FOUR LEVELS OF MOISTURE CONTENT BEFORE TREATMENT WITH DISINFECTANT AND STORAGE.

Seed Treatment	Germination percentage			
	3 days	Air-dried for 24 hours	4 hours	Soaked 4 hrs.
Semesan	92	82	78	0
8-Hydroxyquinoline sulfate	100	94	100	98
Check—untreated	78	90	96	90

TABLE 4  
GERMINATION OF FERIMATE-TREATED AND UNTREATED DUNCAN GRAPEFRUIT SEEDS STORED 2 TO 8 WEEKS AT ROOM TEMPERATURE AT NINE LEVELS OF HUMIDITY, 50 SEEDS PER TREATMENT

Rel. hum in percent	Germination percentage					
	2 weeks		4 weeks		8 weeks	
	Treat.	Untreat.	Treat.	Untreat.	Treat.	Untreat.
9	83	68	36	20	37	29
32	100	96	40	28	44	21
52	100	100	92	88	52	28
76	100	100	88	84	56	60
88	100	100	100	100	100	100
98	100	100	100	87	80	60
99.4	100	100	100	76	36	22
99.7	100	100	100	100	77	56
100	100	100	94	100	100	68

age, although the decrease was less rapid in the treated lots (Table 2). At the higher levels of humidity a high degree of viability was maintained for a much longer period, especially in conjunction with the use of Fermate.

At this point the authors were confronted with the necessity of storing seeds of a large number of citrus varieties that were required for rootstock investigations. Fruits of the desired varieties were collected from several sources, and the seeds were extracted and prepared immediately for storage. In a few instances the seed had been extracted by others and were received in a dry condition. After thoroughly washing and drying on paper towels, all seeds were treated by dipping again in a 1.0 percent aqueous solution of 8-hydroxyquinoline sulfate and dried again on

paper towels before being mixed with moist sawdust or moist ground-up moss (sphagnum-like moss). Excess moisture had been removed from the moss and sawdust immediately prior to mixing, by squeezing the wet material in the hand. Duplicate lots of each variety of seed mixed with moist sawdust (or moss) were placed in half-pint fruit jars fitted with glass covers that were held in place by a wire strap over the top. Rubber sealing rings were not used, and ventilation was provided for by placing a piece of cardboard under one edge of the glass cover so as to raise one side. The seeds were stored at 35°F. until required for planting 6 months later.

Upon opening the jars, nearly all lots of seed were found to be in as good condition as when they were placed in storage. However, several jars of seeds were

TABLE 5  
GERMINATION OF CITRUS SEEDS AFTER TREATMENT WITH 1-0% 8-HYDROXYQUINOLINE  
SULFATE AND STORAGE AT 35°F. FOR 6 MONTHS

Variety of Seed	No. of Varieties	Germination Percent
Pina tangelo, Tangor, Tavares limequat, Seminole tangelo, Lakeland limequat, Rough lemon	7	100
Orlando tangelo, Suwannee tangelo, Minneola tangelo, Duncan grapefruit, Webber tangelo	5	99
Watt tangelo, Cleopatra mandarin, Sweet lemon	3	97
Satsumelo, Hamlin orange, Clementine mandarin	3	96
Ponkan mandarin, Calamondin, Sour orange, Iran lemon, Kalpa lime, Dancy tangerine, Temple orange	7	94
King mandarin, Bergamua sour orange	2	93
Oklawaha sour orange, sweet sdg. orange	2	91
Nagami kumquat	1	88
Bitter Sweet orange	1	77
Uvalde citrange	1	65
Leonardy grapefruit	1	68
Rusk citrange	1	55
Total	34	Ave. 92.6



found to be moldy, and their germination subsequently proved to be poor. In the course of preparing the seeds for storage it was discovered that in a few instances the same solution of 8-hydroxyquinoline sulfate had been used to treat seeds on more than 1 day. It is believed that the moldy lots of seeds were those treated with a spent solution, in view of the general excellence of the other lots in this test and in other tests not reported here. After separation from the sawdust and moss the stored seeds were planted in beds of white sand of 4-inch depth underlain with 4 inches of ground-up peat. Sixty-eight seeds of each variety (four rows across the bed) were planted, half from sawdust storage and half from moss storage. The remaining seeds were

remixed with the sawdust or moss and returned to storage. No difference could be noted in germination of seed from the two storage media, although the sawdust seemed to have dried out less than the moss.

Germination was recorded on approximately half of the number of varieties planted, the other varieties having been removed from the beds for use in another experiment before the record was taken. Germination was recorded for each seed planted so that the presence of multiple seedlings resulting from polyembryony was not a complicating factor. Of the 34 varieties listed, 29 germinated better than 90 percent after 6 months' storage (Table 5).

TABLE 6  
GERMINATION AFTER 8 MONTHS' STORAGE AT 35°F., SEEDS TREATED WITH 8-HYDROXY-  
QUINOLINE SULFATE

Variety of Seed	No. of Varieties	Germination Percent
Watt tangelo, Yalaha tangelo, Orlando tangelo, Suwannee tangelo	4	99
Nippon kumquat, Sampson tangelo	2	97
Nakorn pummelo	1	96
Thong Dee pummelo, Clementine mandarin	2	94
Seminole tangelo, Duncan grapefruit, Pina tangelo, Williams tangelo, Satsumelo, Dancy tangerine	6	93
Natsu Mikan sour orange	1	91
Minicola tangelo	1	90
Ogami pummelo, Cleopatra mandarin, Calamondin, Iran lemon, Kalpi lime	5	88
Hamlin orange, Siamese pummelo, Tavares limequat	3	82
King mandarin, Tangor	2	81
Sweet lemon	1	78
Lakeland limequat	1	74
Leonardy grapefruit	1	66
Kansu	1	62
Sour orange No. 2	1	29
Bergamia sour orange	1	19
Total	33	Ave. 84.5

After 8 months' storage the remaining seeds from the same jars were planted. Records were kept of the germination of all varieties of which there was sufficient seed (68) to plant a full strip in the bed (Table 6). Of the 33 varieties listed, 27 show better than 80 percent germination.

### CONCLUSION

These results give evidence that at least four factors affect the maintenance of viability of citrus seed in storage: (1) microorganisms, (2) moisture, (3) temperature, and (4) aeration.

It has been shown in two instances that viability of citrus seed is greatly depressed by microorganisms (a) the poor germination of untreated seed as compared to Fermate-treated seed (Table 4), and (b) the poor germination of seeds that became moldy in storage at 35°F. due to treatment with a spent solution of 8-hydroxyquinoline sulfate. It is believed that Barton's work on the viability of citrus seed under storage conditions is seriously weakened through inadequate recognition of the importance of this factor.

The moisture or humidity level at which seed is stored is of equal importance with the first factor. The above results indicate that the viability of citrus seed is best maintained by storage at humidity levels approaching saturation (Table 4), though not necessarily by the presence of free moisture.

Indirect evidence was obtained that low temperature promotes longevity of stored citrus seed, through its depressing effect on germination of seed in storage, on respiration of seed, and on the growth of fungi and bacteria, thus supplementing in some measure the action of fungicides.

The fact that dry storage conditions cause serious loss in viability of citrus seeds indicates that they are in a more active state of metabolism than many other seeds. Accordingly, access to sufficient oxygen must be essential to the prolonged storage of citrus seeds.

### SUMMARY

Of the ten compounds tested as surface-disinfecting agents on citrus seed, five (a) Semesan, (b) 8-hydroxyquinoline sulfate, (c) Puratized N5E, (d) thiocyanato aniline, and (e) DuPont 1155H11) were found effective in controlling the growth of microorganisms. Three of these compounds, b, c, and d, were found to be without injurious effect on viability under moist conditions. Citrus seed was dipped in 1.0 percent solution of 8-hydroxyquinoline sulfate and stored in moist sawdust or moss, in nonsealed containers at 35°F. for 6 to 8 months. Of 34 varieties of citrus for which records were available, 29 gave better than 90 percent germination at 6 months; and of the 33 varieties with records at 8 months, 2 gave better than 80 percent.

# OBSERVATIONS ON CITRUS IN ITALY

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Italy and Sicily lie between 36 and 47 degree north latitudes, corresponding to the latitudes of Raleigh, N. C., and the northern border of Maine in our country. It seems a little strange that citrus trees grow and mature fruits so far north, but the climate is warmer than the latitudes indicate, due to the warm waters of the Mediterranean and the Alps and Dolomite Mountains that serve as barriers to the cold north winds. The climate is quite subtropical in Sicily and also on the mainland as far north as Rome. Commercial citrus plantings are numerous in Sicily and in the southern half of the mainland, but home garden and estate plantings of citrus may be found anywhere, even within sight of the Alps.

Both Italy and Sicily are very mountainous and rugged in topography. The mountains are dry, bare, and brown in the summer, and snowcaped in the winter. Two thousand years of sheep-grazing have caused loss of soil and vegetation, except for scrub growth. The foothills and river valleys between mountain ranges now have this soil and are rich and productive. These valleys, a few high plateaus, the narrow coastal plains, and the reclaimed swamplands are just barely sufficient in extent to support the 45 million Italians.

The best and richest lands cannot be given to citrus, because every square meter of land suitable for growing grain must be planted to wheat, corn, oats, rice, or other cereal. Bread comes first. Vegetable crops get the next choice of land. Fruits come third, and must occupy stony fields, steep slopes, or even man-made terraces. And citrus must compete for land with olives, grapes, apricots, filberts, and almonds, and, in the north, with apples, pears, and peaches. Even so, there is a large annual production of citrus fruits. It ran 752,000 metric tons of 2,205 pounds each, prewar. This is about 18 million Florida boxes.

Most of the fruit is consumed in Italy, but a sizable fraction gets into world commerce. We used to import lemons from Sicily, but now the exports go north by train. Locally consumed fruit is sold on road stands or is carried into the large cities in fruit carts decorated lavishly with Biblical paintings and carvings, or in the more modern auto trucks. In the towns fruit stores display the fruit in open trays exposed to the sun, rain, dust, and flies, and sell it by the kilogram or fractional weights of a kilo.

I spent 7 months in the eastern provinces of Sicily, the largest citrus growing area. The plantings were in the rich valley west of Siracusa, around the large valley of the Catania River, around the base of Mt. Etna, in the northeastern province of Messina and around Palermo in the west. Orange and lemon trees were there, but no grapefruit. In September of 1943, just after the invasion,

<sup>1</sup> From 1943 to 1946 with Allied Military Government in Sicily and Italy on military furlough from the U. S. Department of Agriculture



Fig. 1. A citrus grove near Sorrento, Italy, showing protective scaffolding.



Fig. 2. A citrus grove near Sorrento, Italy, showing shade trees and protective scaffolding.



Fig. 3. Another view of citrus grove near Sorrento, Italy.

everything was in confusion. Many people had fled from their city or farm homes and were living in caves up on the mountains. No civilian vehicles were allowed at first to use the roads, and food in the towns soon ran out. Grain was ready to harvest and fruit picking time approached. After the bombings ceased, people walked back to their homes.

Fruit growers faced many problems. Many farm animals and much farm machinery had disappeared. Roads were almost impassable because bridges had been blown up. Railroads had been damaged beyond immediate repair. Fertilizers and insecticides had been scarce for a long time. There were no boxes for packing fruit. All bank balances had been "frozen" by military orders. In a part of Siracusa that had escaped the bombs we found three wood-working shops that ordinarily made the citrus boxes. Usually competitors, they were eager to pool their resources and start to work. They thought they could make 6,000 boxes with the wood and nails on hand, but they had to have a permit to throw the electric power switch on, and a permit to draw out funds from the bank so they could pay the workers. Money was necessary for them to buy bread.

The box assembled there as a sample was very much like the California box. The wood was clean, white, and smooth, neatly nailed, and the box compared very favorably with ours. One difference was that metal strapping was not used. A flexible wood half-round rattan-like strip substituted for the metal.

There were some groves in eastern Sicily that were planted in blocks, as we do, but more were in small, irregular plots and were planted in contours, on

steep terraced, rocky hillsides. Young groves were uniform in growth, but in older plantings the trees showed much variation in size and shape. They were healthy, the foliage being dark green, with no signs of any deficiencies. Many groves had facilities for furrow irrigation. There were a few purple scales and Glover scales, but there was no trace of rust mites or russeting. The scales are controlled there by fumigating occasionally under marked tents with hydrogen cyanide. This was generated by the old "pot" method, using sodium cyanide eggs and crocks of diluted sulfuric acid. In Catania there was a firm that specialized in grove, warehouse, and ship fumigation. The discoid method of application of hydrogen cyanide was known to these workers, as well as the older pot method.

In these groves much use was made of barnyard manure and dried sewage sludge. Most of the sources of commercial fertilizer had been cut off by the war, but the Italians do not depend on it as much as we do. The soil base was rich in minerals, from limestone and volcanic sources, and not like our washed-over sands.

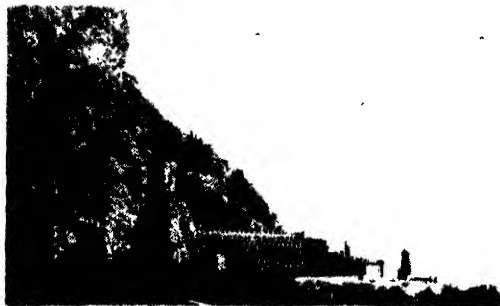
The fruit quality was excellent. The Sicilian variety names meant nothing to us, or to other Italians, but there was a blood orange and one somewhat like the pineapple variety that were welcome additions to Christmas dinner. Both boxes that we bought had fruit nicely washed, graded, and packed. Tissue paper wraps were used, and were printed in color with the brand name, "Micky Maus." Many attempts were made by individual British officers and men to mail packages of these oranges home, where they were badly needed, but the speed of ships in convoy was too slow and the oranges



*Fig. 4. Pile of straw mats used in winter for protection.*



*Fig. 5. The town of Limone, on Lake Garda, in north Italy, surrounded by citrus trees.*



*Fig. 6. A lemon grove north of Limone, Italy, with ornamental cypress plantings, for snow barrier and windbreak.*



Fig. 7. A second grove north of Limone, Italy.



Fig. 8. Details of shed over trees.

rotted in transit. Lemon shipments got there all right. Later on, a British civilian group came to establish commercial shipments to England.

In April 1944 I was moved to the Naples area on the mainland, and spent 11 months there and near Rome. The Naples area, from Salerno to Sorrento and north as far as Terracina, on the coast, and inland around Pompeii, had many citrus plantings. Besides oranges and lemons, there were tangerines, which the Italians called "mandarine." All were excellent in quality. Scale insects were present, but not in damaging numbers. I was told that an outbreak of a red mite similar to our "purple mite"<sup>2</sup> followed the eruption of Mt. Vesuvius, which left fine volcanic ash on leaves and trees and everything else. Incidentally, these deposits of volcanic ash added to the soil every few years keep it rich in mineral elements. Irrigation is used in the groves of this area, too. One grove and an adjoining vegetable field had a well with a chain bucket pump, run by a patient mule walking around and around, guided by a long pole. The gears and spockets in this pump were made of wood.

<sup>2</sup> *Paratetranychus citri* (McG.)

At Sorrento there was a grove between the coast road and the water with an extensive scaffolding of poles through and over it. Here and there, on top of the scaffolding, were piles of woven straw mats, ready to be spread to protect the trees from frost. There were many shade trees in this grove, and these also may have given some protection to the citrus trees below them (Figs. 1, 2, 3, and 4). This grove was an exception, as most of the other groves seen below Rome had no such protection.

In north Italy there were plantings on the coast northwest and southeast of Genova and there was a fine grove in the grounds of the palace of the Kings of Lombardia, near Milano. It was protected by high walls of stone and by a building on the west of it.

On the military maps of north Italy there is a town named "Limone," midway north on the west side of Lake Garda. Since the word means "lemons," I suspected that there might be citrus there, and drove up. I couldn't see how citrus could grow there, almost within the Alps, as the latitude of the place corresponds to that of Bangor, Maine, but I found about a dozen large groves on the steep shores of the lake. Each was

completely surrounded by high masonry walls, had a two-story residence and service house, and was roofed over with a series of heavy iron pipes and poles supported by concrete posts. Evidently in cold weather tarpaulins are used to cover the groves. The German army had fancied the tarpaulins, or else the owners had hidden them to save them. They

were gone. The trees had fruit on them, but were in need of a good fumigation to get rid of the scales. If one considers cost of these installations, the fruit must have been almost "gold plated" when picked. But it is evidence that Italians really love and appreciate their citrus fruit and will have them even at high cost (Figs. 5, 8).

## SOIL MOISTURE AND THE CITRUS TREE ROOT SYSTEM

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Of the environmental factors influencing the growth of citrus which may be controlled at least to some extent, first consideration should be given by the grower to the maintenance of favorable soil moisture throughout the root zone. The roots of bearing citrus trees usually extend laterally a few feet or more beyond the leaf drip. The depth of rooting is primarily dependent on soil texture and certain environmental factors more or less related to soil texture. An examination of the root systems of 17 bearing trees on sour orange and rough lemon stocks growing in heavy soils of low-lying East Coast groves revealed that the maximum depth of rooting here was about 2 feet. The ratio of roots to top was small. On the well-drained sandy soils it is not uncommon to find trees rooted 5 or 6 feet deep. Here the root to top ratio is large. Soil texture in-

fluences root growth both directly and indirectly. The lighter the soil texture the less the mechanical resistance to the growing root. Then there is a close relationship between soil texture and the ability of the soil to retain moisture in favorable amounts.

The importance of soil moisture is due not only to the need of a reserve supply in the soil to replace that lost by the plant through transpiration and the role water plays within the plant in all physiological processes, but also to the control exerted by soil moisture on other soil environmental factors essential to plant growth such as fertility and aeration. Soil moisture is necessary for the solution and movement of nutrients in the soil and their absorption by plant roots. Soil micro-organisms require favorable moisture conditions for the breaking down of organic and mineral nutrient constituents into forms absorbed by roots. Even the soil temperature, which may vary within rather broad limits for root and micro-organism functioning, is some-

times controlled more nearly the optimum by favorable soil moisture. Moreover, the plant roots and most beneficial soil organisms cannot perform properly without sufficient soil aeration which is a function of soil moisture for any given set of soil textural and drainage conditions.

Soil aeration is very closely linked with the amount of moisture in the soil. The soil is a porous mass. Studies on Florida citrus soils have shown them to be from about 40 percent by volume pore space for the light sands to about 60 percent for some loams. These pore spaces are normally filled with air and water. Ideal conditions, on the average, would probably be when they were about half filled with air and half with water. Good plant growth is made, nevertheless, with rather wide variations from this air to water ratio. When healthy plants wilt and remain so through a night of high humidity, most of the pores in the soil in which these plants are rooted are filled with air. When the soil becomes waterlogged the converse is true. Roots cease to function in the absorption of nutrients or water if drought is severe or waterlogging prolonged. In the latter case physiological drought results. Obviously it is the absence of air (oxygen) which really causes root damage under these circumstances. If waterlogging is caused by frequent rains, which will carry fresh water containing some air into the soil, damage is likely to be less severe than when the same water remains without movement for days. Also damage is usually less severe in cool than in warm weather because the absorption of air in water increases as the temperature decreases. Plants growing on heavy loams and muck soils usually withstand waterlogged con-

ditions longer than those on sands because of the considerably larger amount of very small pore spaces in the former from which air is expelled by water quite slowly.

The soil air near the surface generally contains slightly less oxygen than the atmosphere. The percentage of oxygen decreases with depth. The total volume of air in a given soil also decreases with depth except where a false water table may be superimposed above the true water table by a hard-to-wet or impermeable soil layer. As far as the films of water on the soil particles are continuous and connect with the water table the forces tending to drain the soil decrease as the water table is approached. With depth the percentage of pore space filled with water increases. Immediately above the water table there will be a layer of soil very near saturation.

It would be possible to have poor soil aeration even though a large portion of the pore space were filled with air with a high percentage of oxygen if the soil had been compressed by heavy equipment or otherwise so as to greatly reduce the pore space. This would not occur on sands but might occur in soils containing a high clay fraction. However, it probably is not a frequent source of trouble in the surface few feet of Florida citrus soils. Laboratory studies were made on the air holding capacity of a number of soils, representing eight series used for citrus. The soils were thoroughly wetted and drained to equilibrium with a force equal to that present in the soil over a water table at 5 feet. While not absolute, data obtained in this manner do give a fairly close approximation of field conditions. It was found that the volume of air at a depth of 3 feet in a Manatee clay loam was about



13 percent of the soil volume. This value is the air capacity of this soil at 3 feet for these particular drainage conditions. The air capacity at this depth of the soils examined ranged upward to about 34 percent for light sands. Of course the air capacity would increase as the soil surface was approached. An air capacity of about 10 percent is probably about the minimum for satisfactory root growth. In other words, with a water table *maintained* at about 5 feet all these soils could support root growth to a depth of at least 3 feet so far as aeration was concerned. With the water table controlled at a greater depth trees could root deeper than this so long as the soil texture was favorable. Impervious soil layers near the surface sometimes preclude deep rooting regardless of other factors.

It is conservative to say that water has killed and damaged more trees in Florida during the past year or so than any other one cause. The high incidence of water-damaged roots, particularly in coastal areas, is evidence that this trouble is more widespread than generally supposed. Damage has occurred where water did not stand in the middles for prolonged periods. There is sometimes a question in the mind of the grower how water can damage roots when it does not stand in the grove. The installation of a few shallow water-table wells might sometimes be enlightening—and perhaps profitable. Subdrainage is frequently inadequate. We have a number of water-table wells in three groves on different soil types in the Vero area. From these we have found that water often stands near the soil surface in the beds when there is none in the middles. Occasionally it was found to stand sufficiently high in the soil for a couple of weeks

to cause root damage below the 18-inch level. Lateral movement of water through most of the loamy soils is slow. Percolation downward is considerably more rapid. To remedy a situation where periodic water damage occurs may call for more and deeper ditches. In some cases pumps and/or dykes must be installed.

The necessary water control set-up will vary from grove to grove. There is no rule-of-thumb for an adequate drainage installation. In the Indian River section a layer of sand and shell is frequently encountered at a depth of about 4 feet or more. Water percolating downward to this will move out rapidly to ditches cut into it if the ditches are kept at a sufficiently low level. The sand-hill areas usually present no drainage problem except where water from higher areas seeps to slopes and must be controlled by diversion ditches. Some of the lower lying sands are underlain with hard-pan or clay-pan. Lateral movement of water over the surface of these impervious layers may be relatively rapid but movement downward through them is greatly retarded. Judiciously placed ditches at least to the pan depth and sometimes pumps are necessary to permit rooting to as great a depth as the impermeable layer will permit on these soils.

The other side of this soil moisture picture is the maintenance of adequate soil moisture during periods of drought. On the light, sandy, well-drained soils sprinkler-pipe irrigation has been fairly satisfactory. In the artesian areas of the coastal regions flooding between the middles of bedded groves is the method most extensively used. This often is not satisfactory. It is not uncommon to find trees wilted during and immediately

after irrigation. Studies conducted a few years ago on several representative coastal soils showed that frequently little water percolated to the principal root zone even after prolonged flooding of middles except on light sands. Sometimes in an effort to get water into the upper portion of the root zone the period of flooding is of such duration that roots will be killed in the lower portions. Moreover, flooding consumes immense quantities of artesian water. With increased acreage the number of wells have increased. During periods of drought the demand is so great that the flow of individual wells is decreased. Thus it takes longer to get over a given acreage. Drought damage may occur before irrigation is completed. Additional wells are required for a given acreage. The flow is further reduced as the number of wells increase. With this increasing use of artesian waters there is likely to be an increase in saltness of the water. This has occurred in the Indian River section. The salt content of a number of index wells has been determined annually for the past 7 years. This annual survey now includes about 160 wells scattered from Stuart to near Oak Hill. The trend in this area has been a gradual but general increase in salt. During the past year or so rainfall has been excessive throughout the state. The aquifers probably have freshened somewhat. Nevertheless, in Brevard County there was an average net increase this year in salt even though the wells were little used. The wells in the areas farther south showed a slight average decrease, but are still more salty than they were a few years ago.

A few growers in the coastal areas are now using sprinkler irrigation. A satis-

factory response is obtained but there is some question as to whether irrigation is required often enough over a period of years to make it economically feasible. The Citrus Station, in cooperation with Mr. T. A. Peebles of Vero Beach, has set up a field plot experiment to gather information on this matter. The experiment is designed to get a comparison of costs and returns from sprinkler-irrigated, flood-irrigated and non-irrigated plots. Irrigation has been necessary in order to maintain satisfactory moisture in the root zone only on four occasions in the 2 years since the experiment was established. Sufficient rain fell within at least several days after each irrigation to provide good moisture in all plots and eliminate any significant difference between plots with respect to moisture. Yield records for the 2 years show no statistical difference between treatments. In all probability 8 or 10 years will be necessary to collect reliable data of this sort. Recently we have been able to establish a somewhat similar, although more elaborate, set of irrigation plots on the St. Lucie County grove made available for Station use last year by the County Commission through the efforts of the Indian River Citrus League. The plots include oranges and grapefruit on both Parkwood and Sunniland soils.

The length of time a grove will hold up during drought without irrigation is dependent to a great extent upon the spread and depth of the root system. The influence of evaporation extends to a depth of about 6 to 12 inches, depending upon soil texture. The loss of water below this from a soil, once moisture is in equilibrium with the forces tending to drain it rapidly, is primarily through plants growing in the soil. Because of evaporation from the soil surface the

depth of rooting may be more important than the spread in maintaining plant growth during prolonged drought. However, in general, trees set at wide intervals will endure more drought than narrow-spaced trees. This is because the wider spacing provides a larger reservoir of water on which the tree may draw. The depth of rooting is equally as important as the soil texture to which it is related.

The importance of the depth of rooting and the soil texture can both be illustrated by a joint consideration of the moisture characteristics of two soils of rather wide differences in texture and drainage. For example, assume two trees of equal age and top size and both spaced 25 by 25 feet in the grove. One is on a well-drained Norfolk sand and is rooted 4 feet deep. The other is on an imperfectly drained Felda fine sandy loam (tomato land). It is rooted to a depth of 2 feet. Allowing for a slight difference in the volume weight of the two soils, the volume of soil occupied by the tree roots in Norfolk will weigh about 230,000 pounds. The tree on Felda is rooted only half as deep and occupies a volume of soil weighing 112,500 pounds. After being thoroughly wetted and drained to equilibrium with a water table at 6 feet, the surface 4 feet of Norfolk soil will average about 4 percent moisture by weight. This is the field capacity of this soil layer for these particular drainage conditions. Under the same conditions the surface 2 feet of Felda soil will average about 10 percent moisture (field capacity). Plants (any) will remain permanently wilted, even overnight with dew on, when the moisture in the soil in which they are growing is reduced to the wilting point for that particular soil. For

Norfolk sand this is about 1.5 percent moisture by weight and for Felda loams the average is about 5 percent. The moisture available to the plant is that present in the soil between the field capacity and the wilting point of that particular soil. The available moisture to the tree in Norfolk is 2.5 percent of the 230,000 pounds of soil in which it is rooted, or 5,750 pounds of water. The available moisture for the tree in Felda is 5 percent of 112,00 pounds, or 5,625 pounds of water. Thus, while the fine-textured Felda soil has a higher moisture-holding capacity there is slightly less moisture available to the tree in it because of the relatively high wilting point and the shallowness of rooting.

The values used for field capacity and wilting point in this example were obtained by laboratory determinations. They are subject to some error and at best there is always some range. They are to be considered only as approximations. However, they are in fair agreement, on the average, with the moisture content of these soils as determined direct on soil samples from the field taken under varied conditions. This hypothetical case demonstrates how a tree on a fine-textured soil like Felda, with a relatively high water-holding capacity, may wilt during drought equally as soon as one on sand with a low water-holding capacity.

The implications of the foregoing discussion are obvious. The larger the volume of well-drained yet moist soil available to the tree for rooting, the more successful will be its culture. The larger soil volume not only provides more moisture but it is also a larger storehouse for inherent nutrients and those applied in the fertilizer.

On all the light well-drained sands,

where surface evaporation is severe, irrigation to a considerable depth should be profitable. On the imperfectly drained soils improving drainage so as to have good aeration to a depth of several feet is indicated. In some cases the friable soil is only a couple of feet deep. There is little or nothing to be gained in draining more than a few feet below the friable soil layers. Neither is there any advantage to drainage much below the level at which the ground water can be maintained relatively stable during the wet season. The height to which water rises is not so important in this connection, however, as how long it stays there. There is no ultimate benefit in growing roots to a depth where a short time later they will be killed by water. If the drainage or subsoil texture is such that the trees necessarily are rooted shallow then citrus, like herbaceous plants, shows the most vigorous growth with moisture near field capacity. Under such conditions on heavy soils where the nitrogen supply is high the carbohydrates are likely to be utilized for top growth at the expense of the roots. The top to root ratio becomes unbalanced. If flood-

ing occurs the roots may be reduced even further. When flooding occurs, particularly in the summer, it is likely to be followed immediately by high transpiration. The supply of moisture to the fruits is reduced and small fruits result that season. With the long growing season normal for Florida and sufficient nitrogen, vegetative top growth is always inclined to develop at the expense of the roots when moisture is ample. Without irrigation through the occasional droughts shallow-rooted trees may lose sufficient wood from time to time to actually be reduced in size eventually. On the other hand, these same trees if rooted deeply by proper drainage and water control would continue to make good growth year after year—perhaps without any irrigation. There is no question that irrigation is beneficial at times on the heavier soils in the low-lying areas. Nevertheless it is problematical whether it would pay for a very great investment under average weather conditions on the majority of these soils if proper control of the ground water could be secured.

# RELATION BETWEEN POSITION ON TREE AND ANALYSIS OF CITRUS FRUIT WITH SPECIAL REFERENCE TO SAMPLING AND MEETING INTERNAL GRADES

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Pronounced differences in fruit quality have been shown to be related to the position of the fruit on the tree. Winston (1), working in Florida, showed that the soluble solids and vitamin C values were higher in fruit taken from the outside of the tree than from fruit taken from the inside, with no significant differences in acid being found. Wood (2), working in Texas, found that the soluble solids of Marsh grapefruit were higher in fruits taken from the upper portion of the tree than from the lower, and higher on the south and west sides of the tree than on the east and north sides.

Occurrence of this variation brings up two questions: First, can the position of the fruit on the tree be used as a guide in spot-picking the best fruit from the tree; and second, can a small section of the tree be found which will give sample values for internal quality which will accurately represent all of the fruit on the tree?

In order to answer these questions, an intensive investigation of the quality of each orange on a single tree seemed to be the proper first step. These data would provide a firm basis for the solution of the sampling problem. Such data could also be assembled in numer-

ous ways in order to test different methods of spot-picking on the quality of the fruit harvested.

In March 1948, a Valencia orange tree which was considered representative of the variety and bearing an average crop of fruit was selected at the Florida Citrus Experiment Station for use in this study. The selected tree was budded on rough lemon rootstock, was approximately 28 years old, and was in good physical condition. The circular area under the tree was laid off into approximately 19 degree sectors which were plainly marked with large stakes. In this way the area under the tree was marked off into 19 separate sectors, radiating outward from the trunk of the tree. The sector in which the fruit was located was recorded as the fruit was removed from the tree. The height, distance from trunk and distance from periphery for each fruit on the tree was determined within 6 inches by the use of calibrated poles.

Each fruit was classified when picked according to the amount of shade it and the surrounding leaves received. All fruit were placed in one of five "light classes." Fruit in the top of the tree was divided into two of these classes. "Top outside fruit" included all fruit in the top of the tree which was on the outside half of the leaf canopy. "Top inside fruit" was fruit which was in the top of the tree, but in the lower half of the leaf canopy so that it received direct



fruit was in almost full shade continuously. It will be apparent from the descriptions that the basic characteristics used to classify a fruit was the amount of light or of shading to which it and the immediately surrounding leaves were subjected. Figure 1 is a diagrammatic representation of the sectors and light classes into which the lower part of the tree was divided.

These classifications were made at the time of maturity of the fruit. Had they been made at the time the fruit was small in size, no doubt some fruits would have fallen into different classes, due to the sagging and bending of the branches as the fruits increased in weight.

The operations were set up with two crews, one classifying and picking the fruit from the tree, and the second determining the external and internal quality of the fruit in the laboratory. This was done to minimize the time required to complete the observations. Even so, six days were required to complete the removal of the fruit from the tree, and 15 days were required to complete the laboratory determinations. During the interval between picking the fruit and making the laboratory determinations, picked fruit was held at 40 degree F.

In the laboratory the following observations were made on each fruit: Rind color, U. S. Grade, kind of rind blemishes, size, weight, volume of juice, weight of juice, soluble solids, titratable acid, and vitamin C content of the juice. From these figures, the soluble solids/titratable acid ratio of the juice and the percentage juice in the fruit were calculated. In all, over 1,800 individual fruits were so handled. Only the part of these results dealing with internal quality in relation to position of the fruit on the tree are to be presented here.

## RESULTS

Wide variations among individual fruits were found in every chemical characteristic of the juice which was measured. A considerable amount of the variation could be related to the position of the fruit on the tree. Definite trends were noted in the case of soluble solids, ratio, and vitamin C particularly, and slight trends for titratable acidity, while there appeared to be no definite relationship between the amount of juice in the fruit and the position of that fruit on the tree. These juice components will be discussed individually.

*Soluble solids.* The range in soluble solids found in individual fruits was from 5.9 percent to 13.5 percent and the average of all fruit was 10.24 percent. The lowest value was found in a fruit picked from low in the canopy of foliage, while the highest value was found in a fruit picked from the top outside section of the tree. Soluble solids were found to conform to three trends. First there was discovered a trend to higher soluble solids in the top of the tree as compared to the lower part of the tree. Figure 2 shows the average relationship between soluble solids and height for all the five light classes used. The lines in the figure are mathematically computed to fit the many individual values as closely as possible. Each line represents one of the five light classes previously described. In all light classes the soluble solids values increased with height. Using all fruits in the calculations, the soluble solids increased an average of 0.21 percent soluble solids per foot increase in height. For example all fruits picked at a height of 4 feet from the ground averaged 9.0 percent soluble solids, while all those picked at a height

of 14 feet averaged 11.1 percent soluble solids. Figure 3, drawn to scale, gives further examples showing the similarity of trends in all of the three lower light classes.

The second trend noted was the relation among inside, canopy, and outside fruit. All fruit classified as outside averaged 11.08 percent soluble solids, while canopy fruit averaged only 10.01 percent. Fruit classified as inside fruit was considerably lower, averaging only 8.70 percent. It will be noted in Fig. 1 that this trend followed through every

sector into which the tree was divided. Figures 2 and 3 also demonstrate this tendency.

Soluble solids levels were also related to the direction of exposure of the leaf surface to light. Figure 1 shows that fruits taken from the north-northeast section of the tree (sectors 19, and 1 to 4 inclusive) were lower in soluble solids than fruits taken from any other sectors of the tree. Starting from those sectors, there is a gradual but definite increase in average soluble solids values toward the south and west sides of the tree,

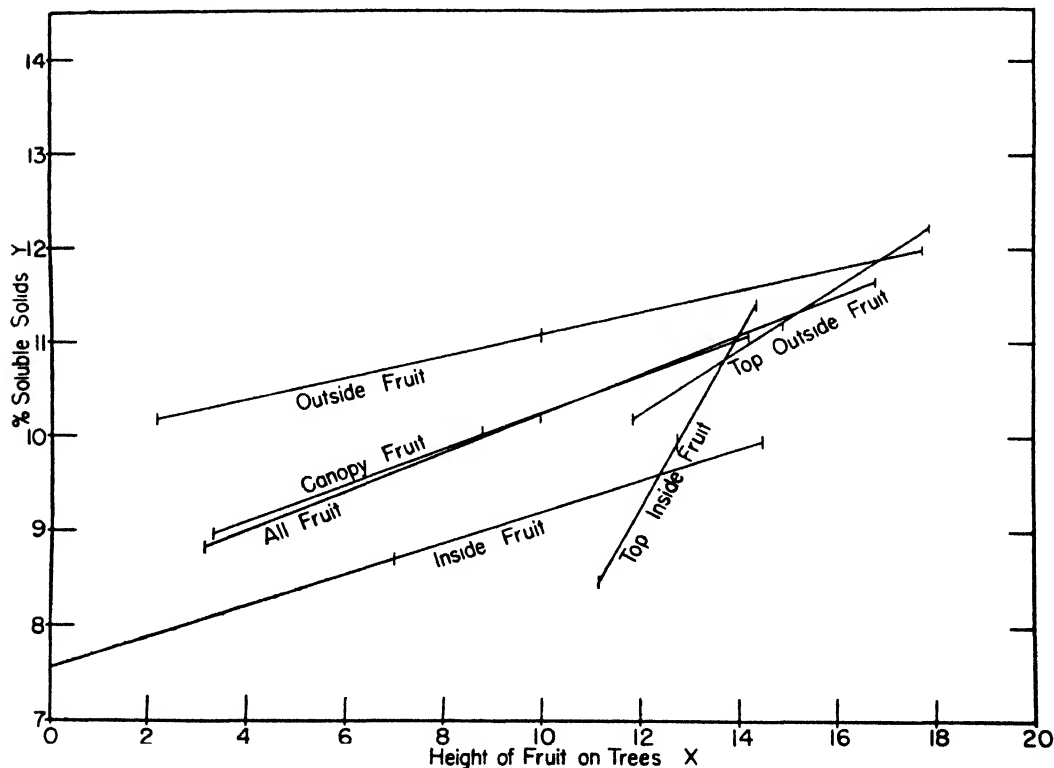


Figure 2. Relation between soluble solids values and height of the fruit in the tree. Each line is mathematically computed from the individual values for fruit in each light class. Average soluble solids is indicated for each light class by the vertical mark at the midpoint of each line.



where soluble solids values are generally equally high. The same trend exists in each of the three light classes shown as well as in the sector averages, although it is most pronounced in the outside fruit, and least pronounced in the inside fruit.

**Titrateable acidity.** Equally wide variation was also found among individual fruits in acidity. The extreme values ranged from 0.50 percent to 1.39 percent. There was no evidence that any of this fruit was "late bloom" fruit. Some may have been, but visible characteristics of "late bloom" were lacking.

Acidity values were also found to follow certain trends, but not as consistently as did the soluble solids values. On the average, titrateable acidity increased at a rate of 0.006 percent per foot increase in height of the fruit. Only a small part of the total range of the acidity could be related to the differences in the height of the fruit. Not only were there small differences related to height, but the trends were mixed among the individual light classes (Fig. 4). On the average, acidity of inside fruit and top inside fruit increased with height, but acidity decreased with height of outside and top outside fruit. Among canopy fruits, there was no relation between height of fruit and the titrateable acidity of the juice.

Differences in acidity between inside, outside, and canopy fruit were also small, and failed to account for much of the variation in acidity. Canopy fruit averaged 0.91 percent acidity, while outside fruit averaged 0.88 percent, and inside fruit averaged 0.86 percent.

Direction of exposure to light was found to have some relationship to the level of acidity in the juice of the fruit. The northeast section of the tree was

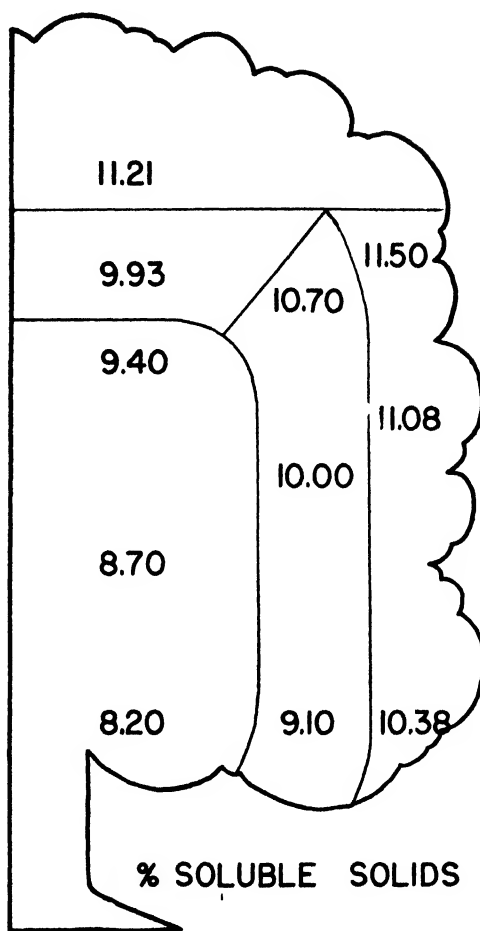


Figure 3. Average soluble solids values for different sections of the tree. Values for top and top outside fruit are averages of all fruit so classified. Other values represent averages of all fruit in the area where the figure is located.

considerably lower in acidity than any of the other sectors, in which the acidity appeared to be rather uniformly higher. Sectors 1 to 4 inclusive (See Fig. 1) ranged in average acidity from 0.72 percent to 0.88 percent, while with only one exception, all the other sector averages

fell between 0.90 percent and 0.96 percent.

**Soluble solids/acid ratio.** In the absence of large differences in the average acidity of fruits, the soluble solids/acid ratio followed trends which were very similar to those found for the soluble solids content of the juice.

Extreme ratio values for individual fruits covered a proportionately wider range than did the extreme values for any other juice characteristic measured. This was no doubt due to the fact that variations in both soluble solids and acidity occurred more or less independently of each other, and at times high soluble solids were found in low acid fruit, and vice versa. The highest individual soluble solids/acid ratio was found to be 21.00 which occurred in the fruit with the lowest acidity. The lowest ratio was found to be 4.80, occurring in a canopy fruit, 3 feet from the ground and on the south side of the tree.

Soluble solids/acid ratios increased consistently with increase in height of the fruit (Fig. 5). Averaging all fruit on the tree, the ratio increased at a rate of 0.16 units per foot increase in height, so that fruit at 4 feet from the ground averaged 10.61 while fruit at 14 feet from the ground averaged 12.22. The increase in ratio with increase in height occurred in all of the light classes about equally, though in the top outside and top inside classifications the ratio increased at a more rapid rate than in the other light classifications.

Outside and top outside fruit was found to have a considerably higher ratio than fruit from the other sections of the tree. The difference between the various light classes is shown in Fig. 5 and amounts to more than 1.5 units in the ratio between canopy and outside

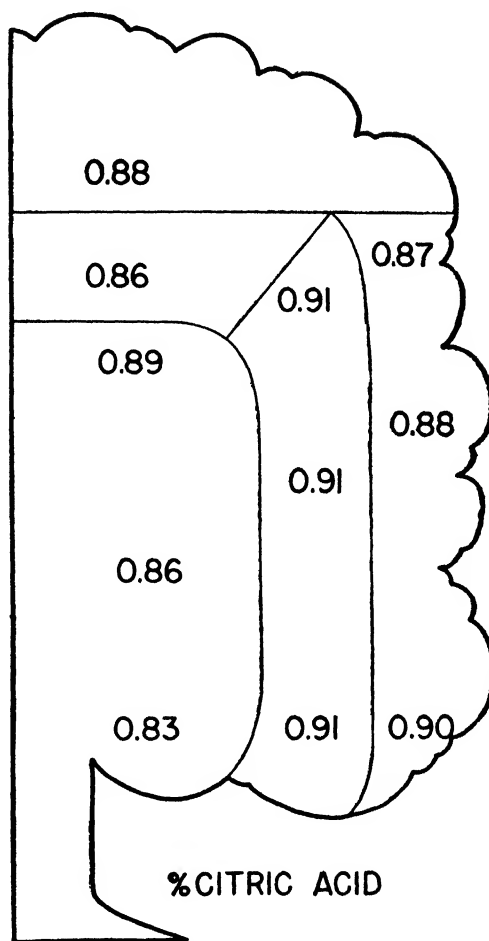


Figure 4. Average titratable acidity in different sections of the tree. Values for top and top outside are averages for all fruit so classified. Other values represent averages of all fruit in the area where the figure is located.

fruit, with an additional 0.85 units between the canopy and inside fruit. This trend is found in all sectors of the tree, regardless of difference in direction of exposure to light, but the trend is most pronounced on the northeast part of

the tree. As noted above, this section of the tree was considerably lower in acidity than other sections of the tree. The soluble solids were also lower in this section of the tree, but not as low in proportion as was the acidity. This

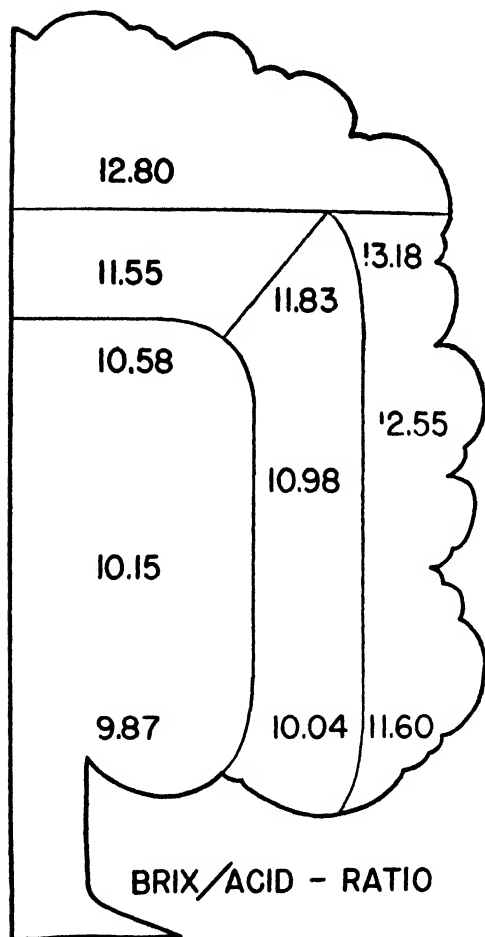


Figure 5. Average soluble solids/titratable acid ratio in different sections of the tree. Values for top and top outside are averages for all fruit so classified. Other values represent averages of all fruit in the area where the figure is located.

resulted in having the highest ratios in the northeast side of the tree. Other sectors of the tree were fairly uniform in ratio.

**Juice content.** The position of the fruit on the tree had little if any effect on the percentage juice in the fruit. There was a slight over-all increase in percentage juice with increase in height, but it was so small as to be of no practical significance (Fig. 6). The direction of exposure of the leaf canopy to light also had little if any relation to the amount of juice in the fruit. Outside and canopy fruit had slightly more juice than inside fruit, but there were numerous exceptions. When the data were examined sector by sector, no trends were clearly established.

The range in juice content of the fruit was smaller than the range of any of the other juice constituents. The high value of 65.8 percent was only 2.0 times that of the low value, compared with a high soluble solids value which was 2.3 times as large as the lowest value, and highest ratio 4.4 times as high as the lowest.

**Vitamin C.** Vitamin C content of individual fruits ranged from 18.2 mg/100 ml. to 59.6 mg/100 ml. with an average value of 37.1 mg/100 ml. Distribution of vitamin C values followed almost the same trends as were found for soluble solids, indicating a high correlation between these two juice constituents. Highest values were found in the outside fruit and especially in the top outside fruit. Canopy and top inside fruit was lower in vitamin C, while the inside fruit was lowest for any of the light classes (Fig. 7). Averaging all of the fruit, the vitamin C content increased at the rate of .75 mg/100 ml. per foot increase in height. The rate of increase

was about the same in each of the light classes, though on different levels as noted above. As with soluble solids, the northeast part of the tree had the lowest values, while there was a trend from this point to higher values in the other sectors of the tree.

The explanation of the extreme variation in fruit quality is thought to lie in difference in intensity and duration of light received by different sections of the tree. Though no light intensity measurements were made, it is obvious that more light fell on top outside fruit and surrounding leaves than fell on low inside fruit and leaves. Since photosynthetic activity of the leaves depends upon the light which falls upon them, top outside fruit lies near leaves which are in the most favored position for active photosynthesis, so far as light is concerned, and would thus be near the source of supply for simple carbohydrates. Other explanations of this variation are possible but the strong correlation between light intensity and fruit quality suggest that light intensity is one of the most important causes for the variations in fruit quality which were observed. The fact that location in respect to light intensity failed to account for all the variation which existed indicates that other factors are also important in determining the quality which an individual orange will attain.

#### SAMPLING IN THE GROVE

In order to develop a sampling technique based on this data it is necessary to select from the many possibilities a height, a light class, direction of exposure of the leaf canopy, and the number and size of fruit to be included. Since the height trends were all computed mathematically, it is a simple matter to

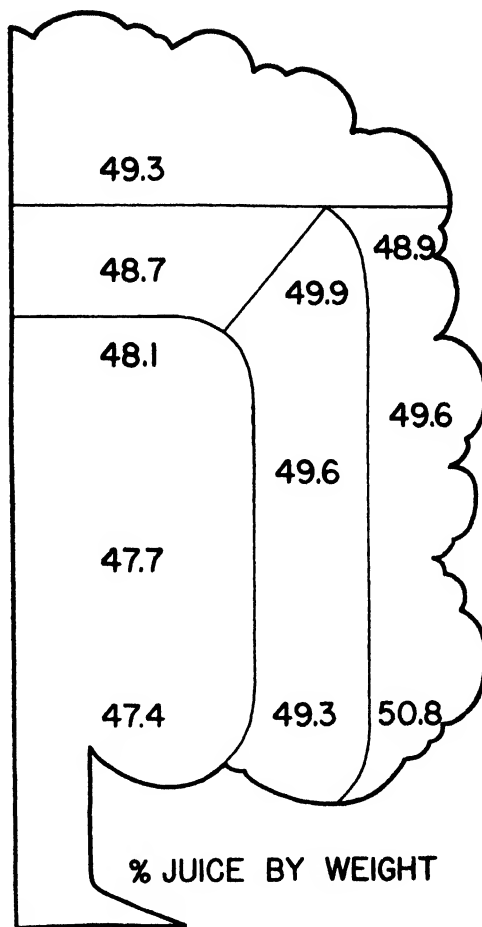


Figure 6. Average percent juice in fruit from different sections of the tree. Values for top and top outside are averages for all fruit so classified. Other values represent averages of all fruit in the area where the figure is located.

compare the average values for all fruit on the tree with the trends for separate light classes, so as to establish the points at which average fruit could be found. Study of the trends reveals that outside fruit at a height of 3 to 6 feet was very similar to the average fruit from this

tree. Soluble solids averaged 10.24 percent for the whole tree while outside fruit averaged 10.24 at a height of 3 feet. Titratable acidity for the whole tree averaged 0.885 percent while at 6 feet the acidity of outside fruit was 0.89 percent. The average soluble solids/

acid ratio for the whole tree was 11.58 percent while the ratio for outside fruit only at a height of 4 feet was 11.60 percent. Vitamin C values for the whole tree averaged 37.1 milligrams per 100 milliliters of juice, while outside fruit at a height of 3 feet averaged 37.8 milligrams per 100 milliliters of juice. Vitamin C values thus appear to be slightly higher than average when using the 3- to 6-foot range of heights. Since juice content did not appear to be related to height of fruit on the tree, it may be assumed that this height will be as satisfactory from that standpoint as any other.

Since the juice analysis of fruit from the northeast quarter of the tree is different from that of the rest of the tree, it would appear necessary to take one-quarter of the entire sample of fruit from this section of the tree, with the other three-quarters of the sample being selected from the rest of the tree. If several trees are being sampled, it may not be necessary to sample all sections of every tree but this proportion should be maintained in the final sample. In testing for fruit maturity, it is necessary to use only fruit of a given commercial size in order to interpret the results of the analysis in relation to the maturity law. This also helps to reduce the sampling error.

Statistical analysis based on the results of this single tree showed that a 20-fruit sample would be necessary for a satisfactory degree of precision in sampling. Even with this number of fruits, there would be one chance in 100 that two samples could be taken from the same plot of trees and give soluble solids values as much as 0.5 degrees Brix different from each other.

It is extremely difficult to make a

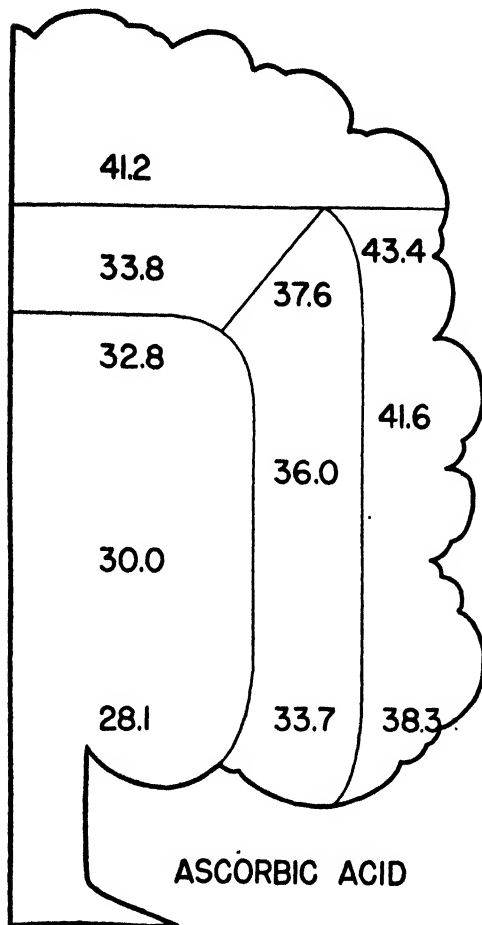


Figure 7. Average vitamin C values in fruit from different sections of the tree. Values for top and top outside are averages for all fruit so classified. Other values represent averages of all fruit in the area where the figure is located.

single set of rules by which fruit from all the different shapes and sizes of trees may be sampled accurately. The data presented justify the above set of recommendations only on the average type of tree. Where trees are overlapping to form hedgerows or overhead canopies, adjustments must certainly be made in the sampling procedure. Adjustments should also be made in case the distribution of fruit on the tree is abnormal, as when the crop is mostly inside fruit or mostly in the tops of the trees. Each grove will present a different problem. Sampling of fruit unfortunately cannot be reduced to a purely mechanical process but must always involve a certain amount of judgment.

#### SPOT PICKING FOR QUALITY

The data make it plain that it is possible to use the position of the fruit on the tree as a guide to the relative quality of the fruit. Whether the fruit is of relatively good or relatively poor quality, the best fruit from the standpoint of internal quality will be in the top of the tree and along the outside of the leaf canopy. If the fruit is generally of high quality this is of little significance but if the fruit is relatively low in internal quality, it may be that the average of all the fruit on the tree is below the standards set by the maturity law. In such a situation the crop need not be a total loss, since the position of the fruit on the tree may be used as a guide to pick only that portion of the crop which will pass the maturity standards.

In the case of this Valencia tree, the quality of the fruit was well above the minimum standards. However, for purposes of illustration, the data obtained in this study have been recombined in Table 1 in such a way as to show how

much the average soluble solids could be changed by leaving on the tree all the fruit from certain poor sections of the tree.

The soluble solids of all fruit on the tree averaged 10.24 percent. By failing to pick the inside fruit, the soluble solids level could have been raised to 10.57 percent, an increase of 0.33 degrees Brix. This would have been accomplished by leaving 17.9 percent of the fruit on the tree. Further examples are shown in the table. By leaving out successively larger proportions of the poorer fruit from the tree, the average soluble solids of the fruit removed could be increased until it reached the upper limit where only the outside and top outside fruit was picked. Less than half of the crop could be harvested in this case but the soluble solids of the fruit picked would be 0.88 degrees Brix higher than the average of all the fruit on the tree.

Under the present maturity standards there will rarely be any practical application for spot-picking for quality except in the case of early oranges, where in some seasons many groves fail to reach the present standards for soluble solids early in the season. In such cases, it may be practical to spot-pick the outside and top outside fruit in order to take advantage of favorable price situations, leaving the lower quality fruit to be picked later in the season when it will pass the maturity test.

Further work is contemplated along the lines suggested above. The results based upon only a single tree confirm and expand the less intensive experiments described in the literature, but also need confirmation on other varieties, and in other seasons of the year. Pending the completion of further work, these

results should be regarded as preliminary in nature.

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TABLE 1

THE EFFECT OF SPOT-PICKING CERTAIN PORTIONS OF THE TREE UPON THE AVERAGE SOLUBLE SOLIDS IN THE JUICE OF THE FRUIT OBTAINED

Section of tree not included	Percent of Total Fruit Included	Average Percent Soluble Solids of Fruit Included
	100.0	10.24
Inside	82.1	10.57
Top inside	92.3	10.26
Canopy	67.6	10.34
Inside and top inside	74.4	10.61
Inside, top inside and canopy	41.9	11.12
Inside and lower 2 feet of canopy	79.9	10.60
Inside and lower 4 feet of canopy	77.3	10.64
Inside and lower 6 feet of canopy	73.9	10.69
Inside and lower 6 feet of canopy and lower 2 feet of outside	73.6	10.70
Inside and lower 6 feet of canopy and lower 4 feet of outside	73.3	10.70
Inside and lower 6 feet of canopy and lower 6 feet of outside	70.4	10.73

# THE INFLUENCE OF ROOTSTOCK ON THE MINERAL COMPOSITION OF VALENCIA ORANGE LEAVES

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This paper is being published in full elsewhere (1) and only a summary of the results is presented here.

Young Valencia trees budded onto six different rootstocks were planted in a random-block experimental area near Tavares in 1942. The soil is Lakeland fine (formerly Norfolk fine) sand. The rootstocks used were sour orange (*Citrus Aurantium*), Rough lemon (*C. Limon*), Rusk citrange (*Poncirus trifoliata* x *C. sinensis*), Bowen grapefruit (*C. paradisi*), Cleopatra mandarin (*C. reticulata*) and Parson Brown (sweet) orange (*C. sinensis*). A complete mixed fertilizer (N, P, K, Mg, Mn, Zn, Cu, and B) was applied uniformly to all plots three times each year. Dolomitic limestone was applied uniformly to the entire experimental area at intervals in amounts sufficient to maintain the acidity of the soil at about pH 5.5. No nutritional sprays were applied at any time. The trees were 2 years old when the experiment started, and had been in the field 5 years when leaves were taken for analysis in late July 1947. Determinations were made for dry leaf weight, ash content, and the individual concentrations of eleven nutritive elements.

The mean dry weight of the leaves was influenced by the rootstock (see Table 1), but there was no consistent relationship of leaf size to tree size. The most vigorous trees, produced by Rough

lemon stock, had the largest leaves. These were 16.7 percent larger than the smallest leaves which were found on the grapefruit stock. Although the total number of leaves per plant was not determined, it seemed apparent that they would vary in the same manner as the size of the trunk.

The percentage of ash in the leaves was less influenced by rootstock than was the dry weight. The leaves from the grapefruit rootstock plots showed the greatest ash content which seemed to be a reflection of the high potassium content induced by that stock.

With the exception of sodium, all of the chemical elements determined show significant differences in concentration due to rootstock. It is evident, therefore, that root systems from different genera of citrus exercise some selectivity in their nutrient uptake. This is based on the assumption that the leaf composition reflects the relative absorption of minerals by the roots. No single element shows a perfect relation between the concentration in the leaf and the size of the tree, yet the two rootstocks that produced the largest trees (Rough lemon and Rusk citrange) also tended to induce the greatest concentration of many of the individual elements in the leaves. This is more readily seen in Table 2, where the rootstocks are ranked in accordance with the increase of each element as percentage of the leaf dry matter. The stock occurring in the upper position in each column contained the least amount of that particular element.



The least vigorous trees, which were produced by sour orange and grapefruit stocks, tend to fall in the upper positions in the columns.

When the chemical constituents were expressed on an absolute basis (i.e., mgm. per leaf) nitrogen alone showed a positive correlation with tree size. These values were 6.8, 6.8, 7.3, 7.4, 7.6, and 8.4 mgm. per leaf for sour orange, grapefruit, Cleopatra mandarin, sweet orange, Rusk citrange, and Rough lemon, respectively. None of the other elements showed a consistent trend in this respect. These differences in the absolute amounts of nitrogen would, in all probability, be magnified considerably if the total number of leaves per plant were to be taken into consideration. This suggests that, if the accumulation in the leaves of any one of the elements measured was a major factor in the different growth rates found, it was nitrogen.

Another point clearly shown by these data is that the micro-nutrient element concentrations were influenced to a greater extent by rootstock than were the macro-nutrient. Thus, nitrogen, phosphorus, and calcium showed only about a 10 to 15 percent increase from the stock with the lowest leaf content to that with the highest. Iron and zinc, however, showed over 100 percent difference between the extremes, and manganese and copper showed about 65 percent each.

Experience has shown that Rough lemon is better adapted to the light, sandy, ridge soils of Florida than other commonly used rootstocks. Young trees grow more rapidly and bear more heavily for a number of years when budded onto this stock. The present findings seem to suggest that the ability of Rough lemon roots to provide the

tops of the trees with larger quantities of nutrients (especially nitrogen) than sour orange roots may account, at least in part, for the above observations. The larger leaf size resulting from the use of this stock may reflect a greater moisture procuring capacity in light soil by the Rough lemon roots.

#### SUMMARY

Valencia orange leaves, from a randomized plot experiment involving six different rootstocks, were analyzed for total ash content and eleven chemical elements.

The results show that the rootstock is of considerable importance in determining the pattern of mineral composition of scion leaves. Highly significant differences in the percentages of nitrogen, potassium, calcium, magnesium, manganese, copper, boron, zinc, and iron attributable to rootstock influence were found. The sodium content of the leaves was not significantly affected by rootstock.

Rootstocks induced larger variations in the concentrations of the micro-nutrient elements found in the leaves than they did in the case of the macro-nutrient elements.

The absolute amount of total nitrogen per leaf appeared to be correlated with tree size. None of the other elements determined showed such a consistent trend. This suggests that there is a differential ability of the stock to supply nitrogen to the scions and this in turn contributes toward producing the different growth rates observed.

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TABLE 1  
SUMMARY OF TRUNK CIRCUMFERENCE, LEAF WEIGHT, ASH, AND CHEMICAL ELEMENT CONTENT OF FOLIAGE OF 5-YEAR OLD  
VALENCIA ORANGE TREES ON SIX DIFFERENT ROOTSTOCKS

Rootstock	Trunk circ. (mm.)	Leaf wt. (mgms.)	Percent in dry leaves						p.p.m. in dry leaves					
			Ash	N	P	K	Ca	Mg	Mn	Cu	Fe	B	Zn	Na
S.O.	165	267	10.49	2.55	0.136	2.11	2.26	0.488	69.0	4.97	74.7	67.3	16.7	485
G.F.	210	264	11.23	2.56	0.141	2.62	2.11	0.369	62.3	5.62	59.3	93.6	21.7	514
Cleo.	212	292	10.60	2.50	0.140	1.97	2.33	0.482	87.7	5.30	87.3	81.1	33.7	489
Sw.	239	282	10.58	2.63	0.150	2.30	2.16	0.408	53.3	7.28	81.7	84.1	18.7	515
Rusk	245	272	10.44	2.81	0.145	1.76	2.41	0.514	80.2	8.34	125.9	94.6	19.7	527
R.L.	288	308	10.89	2.74	0.141	1.98	2.44	0.510	85.0	5.32	101.6	79.7	20.3	497
Maximum diff. (Percent)	74.5	16.7	7.6	12.4	10.3	30.7	15.6	39.3	64.5	67.8	111.9	40.6	101.8	8.7
Sig. of treat.	••	••	••	••	•	••	••	••	••	••	••	••	••	—
L.D. @ 5%	27	20	.38	0.13	0.010	0.22	0.20	0.049	14.7	2.24	13.3	13.1	4.8	—
L.D. @ 1%	36	26	.51	0.17	—	0.30	0.26	0.066	19.6	2.99	17.8	17.5	6.8	—

S.O., Sour orange; G.F., grapefruit; Cleo., Cleopatra mandarin; Sw., sweet orange (Parson Brown); Rusk, Rusk citrange; R. L., Rough lemon.

• Signifies that the odds for significance exceed 19:1, but less than 99:1.

•• Signifies that the odds for significance exceed 99:1

L.D. Signifies the least difference for significance between any two means.

TABLE 2  
RELATIVE RANKING OF ROOTSTOCKS IN RELATION TO THE MINERAL CONTENT OF VALENCIA ORANGE LEAVES WHEN EXPRESSED AS PERCENTAGE OF DRY MATTER

Rank <sup>1</sup>	Trunk circ.	Leaf wt.	Ash	N	P	K	Ca	Mg	Mn	Cu	Fe	B	Zn
1	S.O.	G.F.	Rusk	Cleo.	S.O.	Rusk	G.F.	G.F.	Sw.	S.O.	G.F.	S.O.	S.O.
2	G.F.	S.O.	S.O.	S.O.	Cleo	Cleo.	Sw.	S.O.	G.F.	Cleo.	S.O.	R.L.	Sw.
3	Cleo.	Rusk	Sw.	G.F.	G.F.	R.L.	S.O.	Cleo.	S.O.	R.L.	Sw.	Cleo.	Rusk
4	Sw.	Sw.	Cleo	Sw.	R.L.	S.O.	Cleo	S.O.	Rusk	G.F.	Cleo.	Sw.	R.L.
5	Rusk	Cleo.	R.L.	R.L.	Rusk	Sw.	Rusk	R.L.	R.L.	Sw.	R.L.	G.F.	G.F.
6	R.L.	R.L.	G.F.	Rusk	Sw.	G.F.	R.L.	Rusk	Cleo.	Rusk	Rusk	Rusk	Cleo.

S.O., Sour orange; G.F., grapefruit; Cleo. Cleopatra mandarin; Sw. sweet orange (Parson Brown); Rusk, Rusk citrange; R.L., Rough lemon.

<sup>1</sup> The rootstock in the uppermost position in each column represents the scion-rootstock combination with the smallest measurement for that particular factor, the other stocks being arranged in order of increasing magnitude down the column. Stocks above the underlined one do not differ significantly from each other, while all below differ significantly from the uppermost stock

# EXPERIMENTS ON CONTROL OF THE CITRUS RED MITE

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The citrus red mite has become more troublesome in orange and grapefruit groves in the last decade. Some citrus growers in the Southeastern States know this pest as the red spider or purple mite.

The mite, strictly speaking, is not an insect, but is more like a miniature spider. Full-grown individuals are just large enough to be seen without a magnifying lens. They are dark purplish-red and have four pairs of honey-yellow legs. The citrus red mite is found most frequently on the upper surfaces of the leaves, but it also wanders about on the fruits, lower leaf surfaces, and twigs. The eggs are deep red and spherical in shape. They may be found with the aid of a lens on the upper surface of the leaf, in the angles formed by midrib and leaf veins, or sometimes scattered about on upper or lower leaf surfaces or on the fruit skins, usually in small depressions. The eggs hatch into larval mites, which are similar to the adults except that they have only three pairs of legs.

Two other kinds of mites do damage to citrus trees in the Southeast. The citrus rust mite is much smaller than the citrus red mite, wedge-shaped rather than roundish, and lemon yellow in

color. It causes russetting of the fruit. The six-spotted mite is shaped like the citrus red mite, is greenish-yellow in color with six dark spots on the back, and is found in groups under webbing in depressions on the lower leaf surfaces. Its feeding causes the leaves to buckle, and large yellow spots appear, particularly on grapefruit leaves.

The damage resulting from a heavy infestation of citrus red mites may be considerable. Adults and young mites insert their tiny mouth parts into the leaves and fruit skins and suck out food. The tissues surrounding each feeding puncture bleach out, losing their normal green color. As many as 1,700 feeding punctures have been counted on a square inch on the upper surface of an orange leaf. Such leaves become ashy gray, and heavily infested trees can be picked out at a considerable distance by this loss of normal color. Partial defoliation may occur, the vigor of the tree may be impaired, and the infestation may contribute to the dropping of small, newly set fruits in the early summer. Infestations may subside rapidly without insecticide treatment, but usually not before some damage has been done.

Some of the circumstances responsible for the heavier citrus red mite infestations in recent years are known. In 1937 a severe infestation in grapefruit trees in central Florida followed applications of 6-6-100 bordeaux spray, and adjacent unsprayed trees had almost no infestation. More recently severe infestations have followed the use of nutritional sprays

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<sup>1</sup> John A. Fluno, Minter DuPree, and Nathan Stahler assisted in these experiments.

containing hydrated lime and zinc sulfate, or copper sulfate, or manganese sulfate, or combinations of these materials. In 1940-41 Holloway, Henderson, and McBurnie (1) demonstrated that citrus red mite infestations increased following the use of a spray containing zinc sulfate, copper sulfate, and hydrated lime, and also one containing zinc sulfate plus soda ash. Without doubt, much of the present difficulty with red mites is due to the more widespread use of copper fungicides and nutritional sprays.

The experiments on insecticidal control of the citrus red mite to be discussed below have been in progress for more than 10 years. The results of this work have not been reported previously, but they have been made available to the citrus growers promptly in the cooperative spray and dust programs published annually by the Florida Citrus Commission.

The first experiment of this series was conducted in a grove of grapefruit trees at Isleworth, near Orlando, in 1937. The trees had been sprayed with strong bordeaux mixture and wettable sulfur early in the year, and by June there were heavy infestations of scale insects and citrus red mites. On June 18, 44 trees were sprayed with lime-sulfur, 2 gallons plus wettable sulfur 10 pounds per 100 gallons. Other trees were sprayed with a commercial white-oil emulsion at a strength of 1 2/3 gallons of oil per 100 gallons. Two days before the sprays were applied 71 percent of the sample areas (each 1 sq. in.) examined on the upper and lower leaf surfaces and fruit skins were infested with the citrus red mite. One month after the spraying 84 percent of the sample areas examined on trees that had received lime-sulfur plus wettable sulfur were infested, as

compared with only 13 percent on trees that had been sprayed with oil. It was thus demonstrated that lime-sulfur plus wettable sulfur was ineffective in controlling the red mites, and that the oil-emulsion spray was quite satisfactory.

In 1944 dinitro-ortho-cyclohexylphenol and 4,6-dinitro-ortho-cresol were compared with an emulsive oil for control of citrus red mites. The dinitro compounds were in the form of wettable powders containing 40 percent of active ingredient. They were applied at a strength of three-fourths pound of wettable powder per 100 gallons, either with or without the addition of 10 pounds of wettable sulfur. The emulsive oil was applied at three-fourths gallon of oil per 100 gallons. Samples of 200 leaves showed no red mites alive one week after being treated with oil or the two dinitro-ortho-cyclohexylphenol sprays, whereas a few survived the dinitro-ortho-cresol sprays (Table 1). Five weeks after the spraying many more eggs and mites were found on the trees sprayed with dinitro-ortho-cresol than on the trees sprayed with oil or dinitro-ortho-cyclohexylphenol, which were equal in effectiveness. The dinitro materials were found to be compatible with wettable sulfur.

A third experiment was started in 1945. On March 15 blocks of Valencia orange trees were sprayed with xanthone at 1 or 2 pounds per 100 gallons, or with a commercial emulsive oil at 1 gallon per 100 gallons. The xanthone was dissolved in 1 quart of kerosene in each case, and was made emulsive with 2 ounces of phthalic glyceryl alkyd resin. Two weeks later no mites could be found on 200-leaf samples from the sprayed trees, whereas on trees left unsprayed for comparison similar samples yielded 33 mites.

A fourth experiment was set up in an-

TABLE 1

CONTROL OF CITRUS RED MITE WITH DINITRO AND OIL SPRAYS  
(Applications on January 21 and 24, 1944.)

Treatment (Quantities per 100 gallons)	Numbers per 200 Leaves			
	1 Week After Treatment		5 Weeks After Treatment	
	Mites	Eggs	Mites	Eggs
Dinitro- <i>o</i> -cresol—(40%) $\frac{1}{2}$ lb.	32	868	395	1,585
Dinitro- <i>o</i> -cresol (40%) $\frac{1}{2}$ lb. plus wettable sulfur 10 lb.	7	645	43	233
Dinitro- <i>o</i> -cyclohexylphenol (40%) $\frac{1}{2}$ lb.	0	967	7	88
Dinitro- <i>o</i> -cyclohexylphenol (40%) $\frac{1}{2}$ lb. plus wettable sulfur 10 lb.	0	867	3	104
Emulsive oil $\frac{1}{2}$ gal.	0	988	3	90
No spray	118	892	180	1,308

other grove of Valencias to compare xanthone, dinitro-ortho-cyclohexylphenol, and emulsive oil for control of the citrus red mite. These trees had been sprayed uniformly on April 20, 1945, with a nutritional spray of copper and manganese sulfates plus hydrated lime and wettable sulfur. The treatments, consisting of xanthone 1 pound, dinitro-ortho-cyclohexylphenol (40-percent wettable)  $5\frac{1}{2}$  ounces plus wettable sulfur  $2\frac{1}{2}$  pounds, and emulsive oil 2 quarts per 100 gallons, were applied on June 28. Samples of 50 1-inch squares each on upper and lower leaf surfaces examined on July 6 yielded 14 mites on the xanthone-treated trees, 8 on the dinitro-treated trees, only one on the oil block, and 95 on trees left unsprayed. All three of these sprays gave satisfactory control.

Later in 1945 an experiment was made to compare a commercial emulsive oil with wettable DDT for control of red mites. The wettable DDT was a 50-percent material, extended with pyrophyllite, and was applied at 6 pounds per 100 gallons. The emulsive oil was used at  $1\frac{1}{2}$  gallons per 100 gallons of spray. DDT

was also used in combination with the emulsive oil. The application date was August 22, and 1 month and 2 months later the mites on 1-square-inch samples from 200 leaves were counted for each treatment. The results are given in Table 2. Marked increases in red mite infestations followed the use of the DDT spray. These increases may have been due to the heavy residues of inert pyrophyllite on the leaves, because inert residues are known to encourage red mite increases, or to other factors, such as elimination of beneficial predators. The oil spray alone gave excellent control, and the control was not improved when DDT was combined with the oil.

On July 7, 1945, in a preliminary test of a new material, 1 pound of 10-percent hydroxymethylflavan was dusted on a single orange tree. On August 6, 79 mites were found on 30 1-square-inch samples. In this test the flavan showed no promise for control.

A spray of 15 pounds of wettable sulfur plus 1 pound of dinitro-ortho-cyclohexylphenol (40-percent wettable) per 100 gallons protected Valencia trees

TABLE 2

CONTROL OF CITRUS RED MITE WITH DDT AND EMULSIVE OIL, ALONE AND IN COMBINATION  
(Applications on August 22, 1945.)

Treatment (Quantities per 100 gallons)	Number of Mites	
	Sept. 21	Oct. 18
Emulsive oil 1½ gal.	0	2
Emulsive oil 1½ gal. plus DDT (50%) 6 lb.	0	10
DDT (50%) 6 lb	148	12
No spray	10	6

against infestation by citrus red mites and rust mites from December 11, 1946 to July 2, 1947.

In 1947 several insecticides were tested in combination with wettable sulfur for simultaneous control of rust mites and red mites and other citrus pests. To 6 pounds of wettable sulfur 4 pounds of 30-percent hydroxymethylflavan, 1 pint of chlordane, or 1 quart of Lorol-2-thiazolinyl sulfide was added for each 100 gallons of spray. Suitable dispersants were used to mix the last two in water. The sprays were applied on June 25 and 26. The wettable sulfur plus Lorol-2-thiazolinyl sulfide caused spray burn and severe defoliation, and by September 3 the trees sprayed with the flavan and chlordane combinations had as many red mites as those sprayed with wettable sulfur alone. These combinations were therefore abandoned as unsatisfactory.

A somewhat larger experiment was set up near Fort Pierce in 1947. On May 26 a group of 50 mature Valencia trees was treated with a nutritional spray of copper sulfate, zinc sulfate, and manganese sulfate, 3 pounds each, and hydrated lime 6 pounds, per 100 gallons of water. This spray was applied to encourage build-up of mite infestations and, secondarily, to remedy certain slight nutritional defi-

ciencies. Later these trees were plotted off into 10 blocks of 5 trees each for comparison of four combination sprays with a standard wettable-sulfur spray. The five treatments were randomized in each block, on single-tree plots. The combination sprays consisted of wettable sulfur plus bis(para-chlorophenoxy) methane, parathion, hexaethyl tetraphosphate, (10 percent tetraethyl pyrophosphate) or xanthone. The treatments were applied on June 25 and 26, and again on November 6 (Table 3). At intervals throughout the year and until February 1948, examinations for infestations by rust mites were made, with the aid of linen-tester hand lenses just large enough to cover a 1-inch square. On each tree examinations were made of 10 leaves on the upper surface, 10 on the lower surface, and 10 fruits. Records are based on the numbers of infested squares per 300 examined for each treatment on each date. As usual the wettable sulfur held rust mite infestations to a very low level throughout the year. Six-spotted mites were absent, although adjacent untreated grapefruit trees had serious infestations. Data on control of citrus red mites are given in Table 3.

The red mite infestations remained low for 2 months. On August 5 the trees sprayed with wettable sulfur had

TABLE 3

CONTROL OF CITRUS RED MITE WITH WETTABLE SULFUR AND ADDED TOXICANTS  
(Applications on June 25 and November 6, 1947.)

Treatments (Quantities per 100 gallons)	Number of Squares Infested			
	1947		1948	
	Aug. 5	Sept. 4	Dec. 31	Feb. 16
bis( <i>p</i> -chlorophenoxy)methane (40%)				
2½ lb. plus wettable sulfur 6 lb.	5	33	38	130
Parathion (15%) 6 lb. plus wettable sulfur 6 lb.	1	85	88	140
Hexaethyl tetraphosphate (50%)				
1 qt. plus wettable sulfur 6 lb.	11	72	128	147
Xanthone (92%) 2 lb. plus wettable sulfur 6 lb.	3	60	104	145
Wettable sulfur 6 lb	8	126	163	128

only 8 infested squares out of 300 examined, and the combination sprays were not significantly different from each other. However, the September 4 examinations revealed a sharp increase in infestation, up to 126 infested squares for wettable sulfur alone and up to 33 and 85 for the combination sprays. Wettable sulfur plus bis(para-chlorophenoxy)methane was superior to the other combinations during the summer.

In 1948 this combination-spray experiment was repeated on the same trees with only slight change. The treatments used and the results obtained are shown in Table 4. A peak of red mite infestation followed the treatments, but subsided rapidly in May. The effect of the sprays was determined by counting feeding punctures on samples one-half-inch square from 100 leaves for each treatment. The wettable sulfur plus bis(para-chlorophenoxy)methane gave the best protection against red mite injury for the three-month period. Wettable sulfur plus parathion was also very good, and wettable sulfur plus xanthone gave moderate protection. However, the addition of tetraethyl pyrophosphate to wettable sulfur increased the injury.

Without doubt it killed some mites and many beneficial insects when first applied but, being soluble in water, it was washed away by rains long before the data were taken. Mites probably increased unchecked after residues were washed away, and then did their damage. Multiple applications of tetraethyl pyrophosphate might have given better control, but would have been too expensive. Single applications of bis(para-chlorophenoxy)methane and parathion in combination with sulfur gave prolonged protection.

In a second block of Valencia orange trees near Fort Pierce, it was possible to compare the control of red mites obtained with parathion emulsion and with 1-percent emulsive-oil spray. The parathion was a 20-percent emulsion concentrate. Sprays were made on June 17 and October 21. Red mite counts were taken at intervals throughout the year. The numbers of infested squares per 300 examined are shown in Table 5.

Red mite infestations in unsprayed trees were heavy on July 16, but on August 20 and September 8 they had subsided naturally. There was no rise in the fall or early winter. A month after



TABLE 4

PROTECTION AGAINST CITRUS RED MITE FEEDING AFFORDED TO LEAVES BY VARIOUS SPRAYS  
(Applications on February 19, 1948.)

Treatment (Quantities per 100 gallons)	Number of Feeding Punctures on May 19, 1948
bis( <i>p</i> -chlorophenoxy)methane (40%) 2½ lb. plus wettable sulfur 6 lb.	11,875
Parathion (25%) 4 lb. plus wettable sulfur 6 lb.	18,864
Tetraethyl pyrophosphate (79.4%) 1 pt. plus wetable sulfur 6 lb.	52,888
Xanthone 2 lb. plus wettable sulfur 6 lb.	30,715
Wetable sulfur 6 lb.	40,997

TABLE 5

CONTROL OF CITRUS RED MITE WITH OIL AND PARATHION EMULSION SPRAYS  
(Applications on June 17 and October 21, 1948.)

Treatment (Quantities per 100 gallons)	Infested Squares			
	July 16	Aug. 20	Sept. 8	Dec. 19
Parathion emulsion (20%) 1 qt.	81	3	23	33
Emulsive oil 1 gal.	76	1	1	11
None	95	2	7	8

the first spraying with parathion emulsion the red mites were practically as numerous on the treated trees as on the unsprayed trees. In August this infestation subsided, but built up again in September and stayed high until December 19. In the fall months the parathion emulsion seemed to cause build-up of red mites far above that on the unsprayed trees. The trees that were sprayed with oil in June and October had low levels of red mite infestation throughout the year.

#### SUMMARY AND CONCLUSION

In experiments conducted in citrus groves a spray of lime-sulfur plus wettable sulfur was ineffective in controlling the citrus red mite. Also unsatisfactory were 4,6 dinitro-ortho-cresol, wettable

DDT, hydroxymethylflavan, chlordane, Lorol-2-thiazolinyl sulfide, hexaethyl tetraphosphate, and tetraethyl pyrophosphate.

Increases in citrus red mite infestations followed use of 50-percent wettable DDT, tetraethyl pyrophosphate, or parathion emulsion in sprays.

Oil sprays, in strengths of 2 quarts to 1 2/3 gallons of oil per 100 gallons, gave satisfactory control. However, oil sprays for control of citrus red mites have certain limitations. Oil cannot be used in very hot or very cold weather, or when sulfur sprays or dusts are used against citrus rust mites. Often an oil spray for control of red mites must be an extra application, and extra sprayings are expensive.

Dnitro-ortho-cyclohexylphenol was

found to be compatible with wettable sulfur, and this combination spray gave good control of both rust mites and red mites without the expense of an extra application. However, between May and October, when temperatures approach 90° F., it may cause serious spray burn.

Xanthone and parathion are also compatible with wettable sulfur, and control the citrus red mites reasonably well. Of all the new toxicants tried in combination with wettable sulfur, bis(parachlorophenoxy)methane has given the best and most prolonged control of the red mites. Through 2 years of work it has also been safe for the trees. If further work confirms the preliminary

results with this material, we shall have available a toxicant that can be added to wettable sulfur for combined control of citrus red mites and citrus rust mites, is safe at any time of the year that infestations may appear, and will free growers from the added expense of separate sprayings so often required when oil sprays are used for control of the citrus red mite.

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## A PRELIMINARY REPORT ON THE POSSIBILITIES FOR FORECASTING PERIODS OF OVIPOSITION ACTIVITY FOR PURPLE AND FLORIDA RED SCALES

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During the past 30 years, it has often been suggested (1, 2, 3) that the optimum time for the application of oil sprays for scale insect control on citrus coincided with that period in the life cycle of the scales when there was a maximum of young scales and a minimum of old ones. This period represented a time immediately following egg production and subsequent scale crawler activity. Watson (4) stated that there were three times when purple scale crawlers were most numerous. These periods were usually around April 15, July 1, and September 1. However, no such figures have been quoted for Flor-

ida red scales. The data presented in this report were accumulated between September 1946 and October 1948, and show that both purple and Florida red scales follow regular reproductive cycles. Leaf samples for scale counts were collected in the central part of the State from as far south as Lake Placid and as far north as Weirsdale, and from Vero Beach and Cocoa on the east coast. Some discrepancies are present, but the fact that the data average out and coincide to present State-wide similarity is all the more remarkable when it is considered that these data were usually obtained in the process of other scale insect studies, and were therefore not always taken in an orderly fashion.

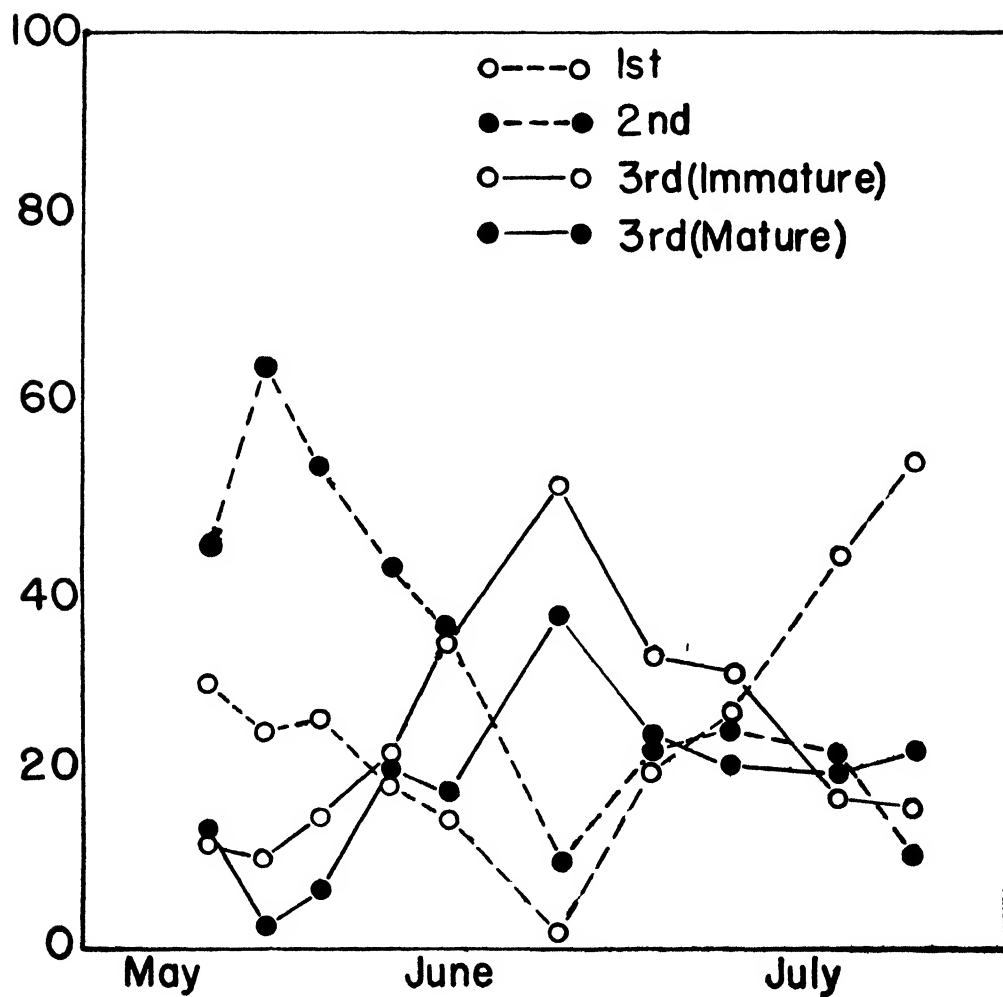
Scale counts were made from leaves picked at random from one or more

TABLE 1  
PERCENT OF PURPLE SCALES IN DIFFERENT STAGES  
FROM SEPTEMBER TO OCTOBER 1948

	Date	No. of Locations	Percent Scales in Each Stage			
			1st	2nd	Immature 3rd	Mature 3rd
1946	September 23	1	37	32	13	18
	October 20	2	33	7	26	33
	November 13	1	31	8	32	27
	December 9	1	25	21	29	24
1947	January 8	2	50	20	13	17
	February 19	3	10	24	51	15
	March 26	3	10	23	52	15
	May 4	3	28	21	25	26
	May 5	2	81	19	0	0
	May 20	2	38	36	16	1
	June 3	1	38	38	21	3
	June 17	3	44	21	21	14
	June 30	2	61	23	3	14
	July 11	2	71	26	1	3
	July 24	2	25	15	23	8
	August 4	3	50	18	13	19
	August 21	3	24	29	15	32
	September 3	3	60	17	10	13
	September 9	2	53	32	5	10
	October 14	1	19	27	8	16
1948	November 11	3	29	32	16	23
	December 22	6	19	29	22	29
	January 8	5	24	35	18	23
	January 27	4	20	30	26	24
	February 5	7	25	30	17	28
	February 13	4	17	37	22	25
	February 28	5	17	38	20	25
	March 11	7	27	40	19	12
	March 19	3	97	4	0	0
	April 17	6	34	45	18	5
	April 27	4	20	61	15	1
	May 4	2	17	35	40	7
	May 22	6	24	40	15	21
	June 6	6	20	43	21	17
	June 16	11	16	31	33	21
	June 27	3	17	28	32	23
	July 6	3	19	34	35	12
	July 20	2	45	26	12	17
	July 30	2	32	36	17	16
	August 11	4	43	27	17	11
	August 20	5	26	29	29	15
	September 2	9	34	22	21	23
	September 14	3	22	32	26	20
	September 27	8	25	35	14	26

TABLE II  
PERCENT OF FLORIDA RED SCALES IN DIFFERENT STAGES  
FROM SEPTEMBER 1946 TO OCTOBER 1947

	Date	No. of Locations	Percent Scales in Each Stage			
			1st	2nd	Immature 3rd	Mature 3rd
1946	September 19	8	35	34	26	5
	October 10	4	54	14	9	23
	October 22	5	64	24	8	4
	November 1	4	37	37	16	10
	November 19	5	35	31	30	4
	December 11	7	33	31	30	5
	December 25	4	36	19	26	18
1947	January 8	8	56	26	12	5
	January 20	4	42	26	25	7
	February 5	6	21	37	33	8
	February 25	11	16	50	32	2
	March 6	11	13	47	37	2
	March 21	5	1	42	55	2
	April 8	4	0	13	85	2
	April 22	5	29	3	46	22
	April 30	3	32	28	22	18
	May 8	2	42	40	10	8
	May 16	2	23	38	27	10
	May 24	5	13	60	24	2
	June 5	2	32	32	36	0
	June 18	4	46	18	23	13
	June 27	6	63	33	3	1
	July 10	1	63	27	8	3
	July 17	5	36	37	25	2
	August 4	6	25	36	34	4
	August 17	5	42	34	18	6
	October 1	2	58	13	23	6
	October 19	3	54	41	3	2
	November 20	5	55	38	8	1
	December 23	3	12	50	26	12
1948	January 20	9	39	32	23	4
	January 28	1	5	40	50	5
	February 23	1	14	14	50	21
	March 9	7	6	48	39	6
	April 8	5	28	29	34	8
	April 9	3	16	73	11	0
	May 15	1	19	25	48	8
	May 24	2	80	11	6	4
	June 18	10	24	34	38	5
	July 7	1	0	47	42	11
	July 26	3	43	37	13	8
	August 8	2	23	28	45	4
	August 22	4	21	48	26	6
	September 10	1	43	36	13	8
	September 24	6	52	31	12	6
	October 7	3	41	27	16	14

**Figure 1****Per Cent of Purple Scales in Each Stage**

trees in a grove. Scales identified as males were not counted, but all female scale and those young ones unidentifiable as males were recorded as to whether they were in first stage (a newly settled scale prior to first molt), second stage (a scale between first and second molts), or third stage. The inclusion of unidentifiable males results in excessive numbers of scales in first and early second stages, but the data are still readily interpretable. The female scales in third stage were further subdivided into those which were immature or not yet laying eggs and those which were mature and were laying eggs. From these counts a percent figure for each stage was computed. The percentages were then arranged chronologically and averaged for a given short period of time (usually less than 2 weeks). The averages were made without regard to geographical location and are presented for purple scales in Table 1 and for Florida red scales in Table 2. The number of groves sampled for each average is also shown. Scale counts were usually made on mature foliage and thus young leaves were avoided when samples were taken. Because of the pronounced flush of growth in the spring of the year, counts were made on old foliage up to a certain date and then from that time one, spring flush growth was selected for scale counting. This change is indicated in the tables and also in the graphs which appear below.

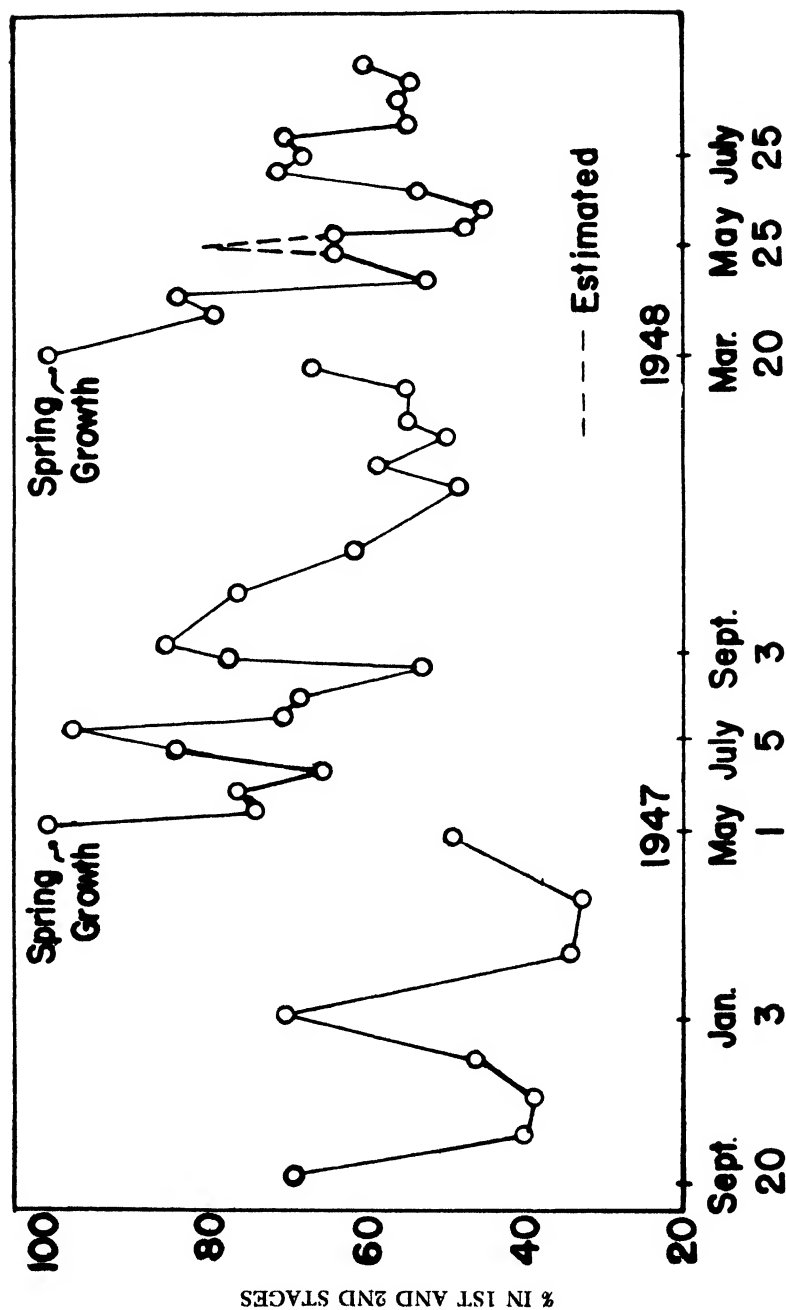
Both purple scale and Florida red scale show similar changes in the percent of scales in any given stage as a function of time. In order to explain these changes, the counts of purple scales made in one grove near Lake Alfred are shown for a period of 58 days in Fig. 1. On May 26, 1948, 45 percent of the

scales were in second stage, 29 percent in first stage, and 13 percent in both immature and mature third stage. By June 1 the number of second stage scales had increased and all others had decreased. Then, as the percent of second stages decreased, the number of immature third stages increased. This would be expected, as the scales in second stage were then becoming third stage scales. The increase in immature third stages was followed closely by an increase in egg-laying females. By June 23, most of the scale population was in third stage. At this time, many eggs were being laid and a period of crawler activity was beginning. Consequently, the number of first stage scales began to increase. On July 23 a majority of the population was in first stage. The reason for the upswing of second stage scales between June 23 and July 8 is not understood at the present time. It may be typical of the expected changes or it may be due to an error in sampling technique. In any case, the general trends appear to be regular and a definite sequence is demonstrable. Data on Florida red scales show that similar changes take place, but that the life cycle is shorter than for purple scales.

In order to simplify the graphic presentation of the data in Tables 1 and 2, the percent of scales in first and second stage is combined and only this figure is shown for purple scales in Fig. 2 and for Florida red scales in Fig. 3. In some instances no counts were made during critical periods, and estimated changes are shown by means of broken lines. It is believed by the authors that these estimates are accurate and that they represent actual populations changes. The peaks in Figs. 2 and 3 are dated and represent periods when most of the scale

FIGURE 2

CHANGES IN THE PER CENT OF PURPLE SCALES IN FIRST AND SECOND STAGES DURING A TWO YEAR PERIOD



population was in first and second stage. As would be expected, these periods followed times of maximum oviposition. If the percent of scales in mature third were also plotted on these graphs, it would be found that maximum oviposition periods coincide with a minimum of scales in first and second stage and that they precede the increases in first and second stages shown in the graphs.

The graphs demonstrate that there were definite and relatively regular cycles for both species of scales, and strongly suggest the possibility that such population changes could be anticipated several weeks in advance. In both 1947 and 1948, the initial oviposition periods for both species of scale coincided with the approximate time of the onset of bloom. Similar observations have been made by the authors in previous years. Although the exact reasons for this phenomenon are not fully understood, it appears that winter temperatures may produce a leavening effect such that the scales grow very slowly, lay a minimum of eggs, and the few eggs that are laid hatch only after long intervals. Thus, the winter ends with the bulk of the scale population either laying eggs or about to lay eggs, but with little hatch occurring. Apparently the weather cycle which causes a tree to grow and bloom in the spring also causes the infesting scale population to grow and to increase the rate of oviposition. As a result, periods of bloom and spring oviposition of the scales tend to coincide.

Following the spring oviposition period in 1947, there were only two more pronounced oviposition periods for purple scales. One was about July 1 and the other about September 1. Thus, 1947 corresponds to the periods noted by Watson (4), and 1947 was a year

with a relatively normal blooming date. In the case of red scales, there were three additional oviposition periods, which is one more than for purple scale. For both species of scales, there was a slight increase of young scales in late January 1948. It is possible that this period was comparable to the pronounced oviposition period shown during the warm period in early January of 1947, but that the 1948 period was an abortive one due to the cool weather which occurred in that year.

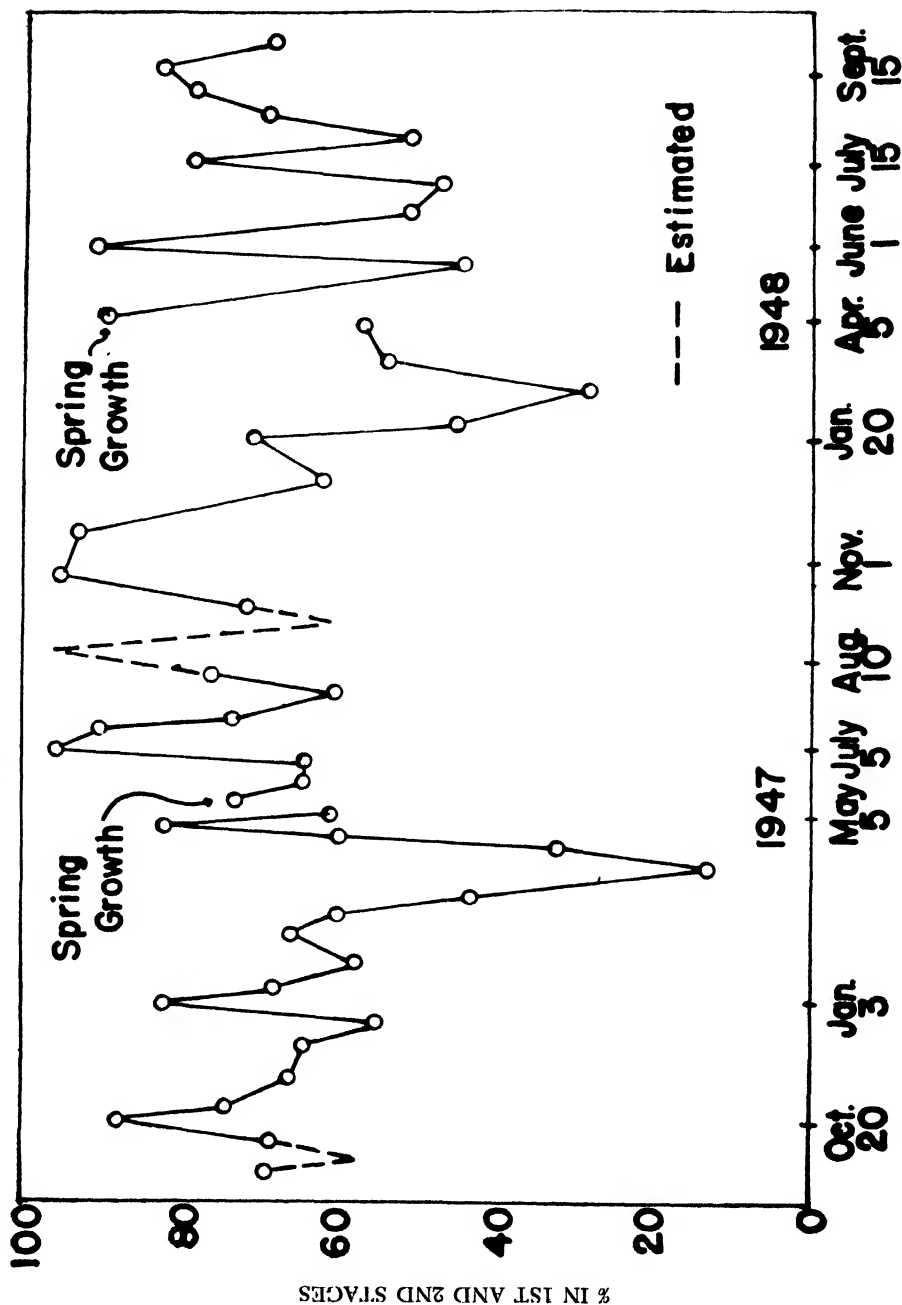
The 1948 growing season was characterized by an early flush of spring foliage, an early bloom, and also an early time for scale crawlers to appear in large numbers. Post-bloom sprays were applied in some areas prior to March 15. This was a month earlier than in 1947 and is quite comparable to the spring of 1946 when crawler periods occurred in late March. As a result of the early spring in 1948, the second generation of both red and purple scales occurred in late May and early June, respectively, and by October both species had produced one more generation than in 1947. This represents a similar situation to that which occurred in 1946. Thus, it may be expected that the generally heavy scale infestations which started with an extra generation in 1946 due to an early spring and late fall, and which have continued through 1947 and 1948, may well continue into 1949.

One abnormal fluctuation of red scale in Fig. 3 can be explained. According to the graph, it appears that in February 1947 there was a response to an oviposition period. The rise in the percent of scales in first and second stages was actually caused by another set of circumstances. The severe freeze which occurred in early February 1947 resulted



FIGURE 3

CHANGES IN THE PER CENT OF FLORIDA RED SCALES IN FIRST AND SECOND STAGES DURING A TWO YEAR PERIOD



in the elimination of practically all first stage and mature third stage scales. This left the majority of the scales in second stage, which shows as an increase in young scales on the graph.

For both species, the time between oviposition periods was shortest during the summer months. It may be calculated at about 8 weeks for purple and 6 weeks for red scales. Cooler weather in the fall or winter materially lengthened the period between oviposition periods.

Before completely accurate forecasts can be made for any given citrus area, further study of weather relationships is essential, as well as a closer examination of the exact manner in which the percent of a given stage changes from day to day. In addition, the possibility that population changes may be slightly different in the widely separated citrus areas of Florida must be considered. However, the basic information already available should make it possible to forecast with some degree of certainty the approximate times when scale populations will be largely composed of young insects. This information should help the individual grower or the production manager to better time oil sprays in heavily infested groves. The forecasts will, of necessity, be limited in scope, but it is hoped that additional experience will render them ever more useful.

### SUMMARY

Actual populations changes for both purple scales and Florida red scales are shown by means of graphs for the period September 1946 to October 1948. The changes in the percent of scales in a given stage appeared to be similar throughout the citrus producing areas of Florida. Florida red scales averaged at least one generation more per year than did purple scales. Both species had initial periods of oviposition which coincided approximately with bloom time in the springs of both 1947 and 1948. Oviposition periods follow one another in regular sequence, and it is concluded that forecasting of periods when the bulk of the scales are in first and second stages should be practical for the 1949 season.

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# EFFECT OF METHODS OF APPLICATION ON COPPER, SULFUR, AND OIL DEPOSITS OBTAINED BY SPRAYING AND DUSTING

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The problem of applying spray and dust materials to citrus is an important one. The effectiveness of any given application may be determined not only by the amount or kind of materials used, but also and probably of greater importance, by the thoroughness of the application. The data presented below were collected from a series of different experiments. They emphasize the fact that initial average deposit is not always a criterion of the effectiveness of the treatment, and that control is dependent upon complete coverage and thoroughness of application.

## COPPER DEPOSITS

Two experiments concerned with copper are reported below. One was designed to study melanose control on grapefruit trees. It compared the effectiveness of several proprietary copper-oil emulsions with a bordeaux (3-3-100) spray and with a copper oxychloride material. The plots were randomized and in duplicate. They were sprayed on April 28, 1947. The copper oils and the copper oxychloride were used at the copper equivalent of a 3-3-100 bordeaux and the oils at 1.3 percent actual oil. The gallons applied per tree were essentially the same and all sprays were applied with conventional pressure spray equip-

ment. Copper deposits were determined on the foliage as soon as the spray had dried and at the end of 6 weeks which period is usually considered the critical one for melanose infection. The fruit was picked and graded for melanose the following March.

The results as shown in Table 1 indicate that a highest amount of copper was deposited on foliage by the copper-oil emulsions and that following this type of application more copper remained during a longer period. It appears that the average amount of copper present on the foliage may not be the most important factor in controlling melanose, since no better melanose control was affected by the use of the copper-oils, and, in fact, the best control was obtained with the copper oxychloride material where there was less copper initially and throughout the critical period.

In the second experiment some plots of orange trees were sprayed with basic copper sulfate and wettable sulfur and others with a proprietary copper-oil (at copper equivalent of a 3-3-100 bordeaux and 1.3 percent oil). This experiment was originally designed as part of a scale insect study. However, due to an increase of purple mites (*Paratretranychus citri*) copper deposits were checked 6 months after the application. Results are presented in Table 2. As in the experiment described above considerably more copper was retained on those plots which were sprayed with copper-oil. The purple mite infestation was considerably

TABLE 1

COPPER-OIL VERSUS COPPER-WETTABLE SULFUR SPRAYS ON GRAPEFRUIT

Material <sup>1</sup>	Copper Deposits mcg/cm <sup>2</sup>		Percent No. 1 Fruit <sup>2</sup>
	April 28	June 9	
Neutral Copper <sup>1</sup>	4.7	1.3	71.7
Bordeaux (3-3-100)	5.0	1.8	60.5
Copper Oil A	7.3	5.7	60.9
Copper Oil B	6.7	5.0	57.8
Copper Oil C	5.5	3.9	61.5
Copper Oil D	7.0	3.8	56.5

<sup>1</sup> Dilutions made on basis with metallic copper content contained in 3-3-100 Bordeaux.

<sup>2</sup> Figures obtained from Dr. R. F. Suit, Pathologist, Citrus Experiment Station.

<sup>3</sup> A copper oxychloride material.

TABLE 2

A CORRELATION BETWEEN COPPER DEPOSITS ON LEAVES AND PURPLE MITE INFESTATIONS 6 MONTHS AFTER THE COPPER APPLICATIONS

Plots	Copper Spray Combinations Applied May 6	Dates of Summer Oil Sprays	Copper Deposit On Foliage mcg/cm <sup>2</sup>		Percent Leaves Infested with Purple Mites	
			Av.		Av.	
5	Copper-W. Sulfur <sup>1</sup>	—	1.6	1.8	10	8.0
23			1.9		6	
2	Copper-Oil <sup>2</sup>	—	3.7	3.4	67	59.0
20			3.0		51	
8	Copper-W. Sulfur	June 3	1.7	2.2	23	25
26			2.7		27	
1	Copper-Oil	June 16	3.7	4.0	73	64
19			4.3		55	
12	Copper-W. Sulfur	July 14	2.5	1.8	2	6.0
30			1.2		10	
3	Copper-Oil	July 14	3.3	3.7	64	63.5
21			4.1		63	
13	Copper-W. Sulfur	Aug. 4	2	1.9	1	1
21			1.8		1	
4	Copper-Oil	Aug. 4	5	4.8	11	11
22			4.7		11	

<sup>1</sup> Neutral copper (34% metallic Cu) @ 3 — 100+ wettable sulfur 12% — 100.

<sup>2</sup> Proprietary copper oil emulsion @ 2 gallons — 100.

higher on the copper-oil sprayed plots, and only the August 4 oil spray seemed to have materially reduced the purple mite infestation. No reason for the build up of purple mites can be deduced at this time, but this experiment appears to substantiate field observations which indicated that purple mite infestations in the fall of the year often follow spring applications of copper-oil sprays.

#### SULFUR DEPOSITS

In January of 1948 an experiment was prepared to study different methods for the application of sulfur. Three types of dusters were compared with the Speed Sprayer (Model 36) application. The conventional two-tube duster and the Master Fan Duster were operated at approximately 3 miles per hour while the third type, the airplane, was flown at about 75 to 80 miles per hour. The Speed Sprayer with the double-head attachment was driven at a speed of 1.3 miles per hour. The materials were applied to both sides of the trees by all applicator equipment except by the airplane which was flown over the top of each row of trees. The amounts of sulfur applied by the various applicators varied between 1.4 and 1.6 pounds per tree. The data on materials used, the deposits of sulfur obtained, and the rust mite control are recorded in Table 3. The final analysis of sulfur deposits was made 33 days after the application while the final rust mite inspections were made 81 days after the application.

Commercial control of rust mites was obtained with all applications. However, the sprays gave better results than the dusts. After 81 days the range of infested leaves on sprayed plots was from 2 to 6 percent while a range of 5 to 21 percent was obtained in the dust

plots. This difference can be partially explained by the fact that the sulfur was distributed over both the upper and lower surfaces of the leaves when applied as a spray, whereas when applied as a dust, a high percentage of the sulfur was on the upper leaf surfaces. There was no correlation between the average amounts of sulfur deposited and the rust mite control obtained since the average amounts of sulfur deposited by the dust were as great or greater than those deposited by the sprays. Therefore, distribution and coverage of the tree with sulfur appeared to be the most important factor governing rust mite control.

In another experiment the uniformity of the sulfur deposited was determined where various methods of application were used. The Speed Sprayer with an average sulfur deposit of 61 gave the lowest standard deviation of plus or minus 16 while the Master Fan Duster with an average sulfur deposit of 72 gave a standard deviation of plus or minus 24. The conventional duster gave the highest average sulfur deposit, but had the highest standard deviation which was plus or minus 56. The above results indicated that more uniform amounts of sulfur were deposited by the Speed Sprayer than by the dust applicators and therefore also suggest that distribution and coverage of the foliage is more important than the average amount of sulfur deposited.

#### OIL DEPOSITS

*Type of Spray Guns and Disc Size.* A comparison of double Boyce guns (2 nozzles) with the broom guns (4 nozzles) was made using the same spray machine, spray crew, pressure, water, and sources of oil. The sizes of the spray discs, however, were varied. The

TABLE 3  
RUST MITE CONTROL WITH VARIOUS MATERIALS AND TYPES OF APPLICATORS

Type of Sprayer And Dusters	Materials and Dilutions per 100 Gallons	Sulfur Deposit mcg/cm <sup>2</sup>				Percent Reductions of Rust Mite Infestations
		Outside Canopy		Inside Canopy		
		Initial	Final	Initial	Final	
Speed Sprayer	Lime-sulfur 2 gals., w. sulfur <sup>1</sup> 5 lbs., DN <sup>1,2</sup> 2/3 lbs.	60	16	31	9	81
Speed Sprayer	W. sulfur 10 lbs., DN 2/3 lbs.	43	4	45	6	65
Conventional <sup>1</sup> Duster	1½ DN-Sulfur dust	165	13	61	3	31
Master Fan Duster	1½ DN-Sulfur dust	72	4	46	3	69
Airplane <sup>2</sup> Duster	1½ DN-Sulfur dust	91	2	54	2	53
Speed Sprayer	Lime-sulfur 2 gals., w. sulfur 5 lbs., Neotran <sup>3</sup> 2 lbs.	72	16	62	22	76
Speed Sprayer	W. sulfur 10 lbs., Neotran 2 lbs.	55	2	49	6	85
Conventional Duster	4% Neotran <sup>3</sup> -Sulfur dust	107	9	45	0	5
Master Fan Duster	4% Neotran-Sulfur dust	59	3	29	1	6
Airplane Duster	4% Neotran-Sulfur dust	61	4	29	3	14

<sup>1</sup> Conventional duster—double flexible tube type.

<sup>2</sup> Stearman PT 17.

<sup>3</sup> W. sulfur—wetttable sulfur.

<sup>1</sup> DN—dinitro-o-cyclohexyl phenol.

<sup>2</sup> Neotran—bis (P chlorphenoxy) methane.

<sup>3</sup> DN and Neotran used for purple mite control.

TABLE 4  
OIL DEPOSITS RESULTING FROM THE USE OF DIFFERENT SPRAY GUNS AND DISC SIZE AT  
COUNTY GROVE, FORT PIERCE

Type of Spray Gun	Size of Disc	Oil Deposit mcg/cm <sup>2</sup>			
		Lower Canopy		Top Canopy	
Broom-4 Noz.	5's	42		39	
Broom-4 Noz.	5's	56	46	37	30
Double Boyce	5's	48		25	
Double Boyce	5's	48	50	42	45
Double Boyce	7's	53		55	
Double Boyce	7's	52	46	54	56

trees sprayed were fairly uniform and averaged around 17 to 18 feet high. About two-thirds of the spray was applied from the inside of the canopy of the trees. The samples for determination of oil deposits were collected as soon as the trees were dry. The results as shown in Table 4 indicate that the double Boyce guns fitted with 5/64 in. and 7/64 in. discs produced higher oil deposits in the top parts of the trees than did the broom guns fitted with 5/64 in. discs. The results further show that with double Boyce guns the larger size discs deposited more oil in the tops of the trees than did the smaller size. These differences can be explained by the fact that the double Boyce gun could be regulated to deliver a wide mist or a narrow stream with more force while the broom guns only deliver a wide mist which does not have enough force to properly deliver the spray to the top of the tree. These results partially confirm earlier work of Thompson (1) who made a study of the types of spray guns and determined the relative efficiencies by scale-counting methods.

In connection with the above experiment a survey of actual commercial applications of oil sprays was made in an area where the broom guns were in general use. The types of spray machinery

varied and this factor was not considered. However the types of spray guns, the disc sizes, and the resulting oil deposits are included in Table 5. In general, low amounts of oil were deposited in the top parts of the trees, and in most cases this was not the fault of the spray crews, but was due to the failure of the broom guns to deliver a sufficient amount of material to the top portions of the trees.

*Rate of Travel of Speed Sprayer (Model 36).* The efficiency of the Speed Sprayer equipped with the single side or "oil-head" attachment was studied by operating the machine at speeds of 0.8, 1.2, and 1.6 miles per hour and then determining the amounts of oil deposited inside the canopy of the tree in three positions: on the onsides which are adjacent to the sprayer; the offside which are perpendicular to the direction of travel; and the top. The trees sprayed were fairly uniform in shape and were 18 to 20 feet high. The gallonage delivered to each tree was approximately the same and was obtained by adjustment of the number of jets in the spray head. The plots were selected so that very little spray delivered to the trees at one speed would reach trees sprayed at another speed. The results as shown in Fig. 1 indicate that as the operating speed of the sprayer is increased the

TABLE 5

OIL DEPOSITS FROM VARIOUS GROVES SPRAYED BY DIFFERENT OPERATORS AND GROWERS IN THE  
FORT PIERCE AND VERO BEACH AREA

Grove Number	Type of Spray Gun	Size of Disc	Oil Deposit mcg/cm <sup>2</sup>		
			Lower Canopy	Top Canopy	Top Canopy
1	Broom-4 Noz.	3 & 4	33	26	—
2	Broom-3 Noz.	4's	65	61	30
3	Broom-4 Noz.	4's	44	42	—
4	Broom-3 Noz.	3 & 4's		36	—
	Single	4		36	—
5	Broom-3 Noz.	4's	46	56	37
6	Broom-3 Noz.	3's	30	52	42
7	Broom-4 Noz	3 & 4's	61	80	35
8	Broom-4 Noz	4 & 5's	47	42	6
9	Speed Sprayer	6/64	44	40	20
10	Speed Sprayer	6/64	70	63	—

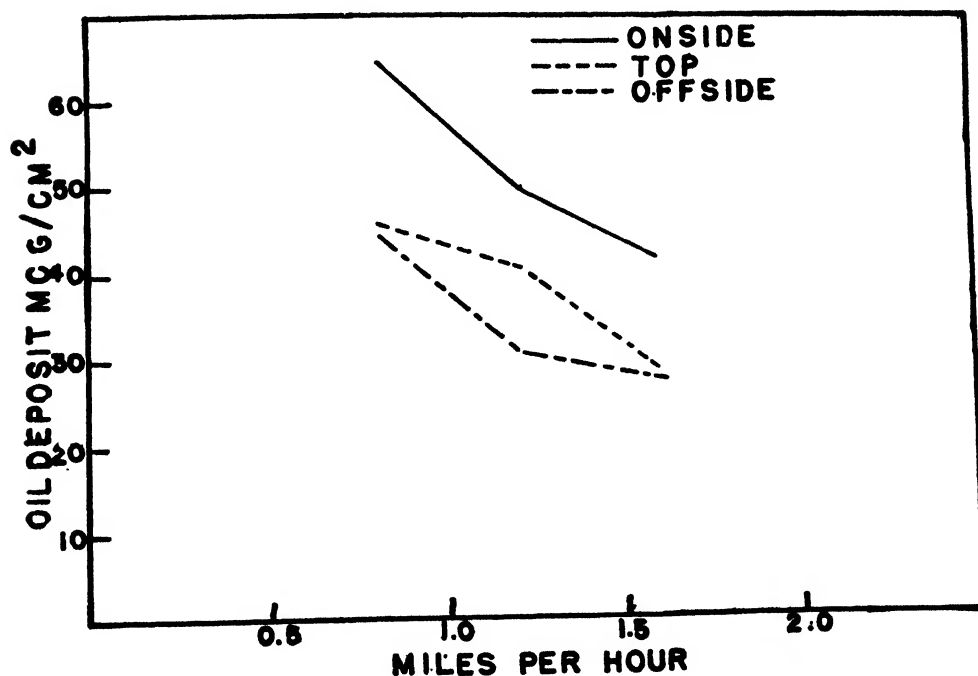


Figure 1. The effect of operating speeds of the "Speed Sprayer," Model 36, on oil deposits on the inside canopy of tree.



amounts of oil deposited on the inside canopy and in the top decrease in spite of the fact that the same relative gallonage was delivered to the trees at the different operating speeds.

#### SUMMARY

More copper was deposited initially and more was retained over a period of time where copper-oils were applied than where bordeaux (3-3-100) and a copper oxychloride material were applied. There was no correlation between average amounts of copper deposited and resulting melanose control.

Distribution and coverage are more important criteria for control of rust mites than initial average amounts of sulfur deposited. Sulfur sprays applied by the Speed Sprayer gave better control of rust mites than did sulfur dusts applied by either ground dusting equipment or by the airplane. More uniform

amounts of sulfur were deposited by the Speed Sprayer than by the ground dusting equipment.

Double Boyce guns equipped with 5/64 in. and 7/64 in. spray discs gave higher oil deposits in the top parts of the tree than did the broom guns with 5/64 in. discs. Higher oil deposits in the top parts of trees were obtained with 7/64 in. discs than with 5/64 in. discs when both were used in double Boyce guns. The amounts of oil deposited on the inside canopy of the tree and in the top were decreased as operating speed of the Speed Sprayer was increased from 0.8 to 1.6 miles per hour although the gallonage applied per tree was approximately the same.

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## STATUS OF PARATHION AS AN INSECTICIDE FOR FLORIDA CITRUS

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At the 1947 meeting of the Florida State Horticultural Society, Thompson and Griffiths (3) stated that of the newer insecticides which were being tested diethyl p-nitrophenyl thiophosphate, THIOPHOS 3422, or parathion looked promising as a scalicide. Parathion has been accepted as the common name for this material, but it is being sold under various trade names. This paper is a progress report on some of the

experimental work which has been done with parathion during the past year on the control of scale insects and mites infesting citrus trees. Parathion was used in the form of a wettable powder in all experiments.

*Amounts.* Parathion will kill purple and Florida red scale, but the minimum amount to use for effective control has not been definitely determined. Results of preliminary tests indicated that .5 of a pound of the active ingredient per 100 gallons would be necessary for a maximum kill of purple scales, but more recent experiments showed that an amount between .15 and .30 pound per

100 gallons might be sufficient. There has been a consistently higher percentage of kill with 0.5 lb./100 gal. than with lesser amounts. Nevertheless, some very effective control has been obtained with the lower concentrations. In seven different experiments, the leaf infestation of purple scales was reduced with parathion at 0.5 lb./100 gal. on an average of 96 percent with a range of 92 to 99 percent. In five experiments, parathion at 0.3 lb./100 gal. reduced the scale infestation on an average of 91 percent with a range of 79 to 99 percent. Where 0.2 lb./100 gal. was used in two experiments, the infestation was reduced 84 percent in one instance and 99 percent in the other, and where .15 lb./100 gal. was used, there was a reduction of 75 percent and 90 percent. An oil emulsion, at 1.3 percent actual oil, was used in five of these experiments and this caused an average reduction of 80 percent with a range of 56 percent to 94 percent.

Florida red scales were as effectively controlled as purple scales with parathion, but fewer experiments were conducted for red scale control.

*Compatibility.* Parathion was tested with most of the materials used in sprays applied to citrus trees. It was used in combination sprays containing wettable sulfur, neutral compounds of zinc and copper, DN (dinitro-o-cyclohexyl phenol), Neotran (bis(chlorophenoxy)-methane) and borax. It was also tested in sprays containing zinc sulfate and/or manganese sulfate which were neutralized with hydrated lime. According to the manufacturer, parathion should not be used in strongly alkaline solutions. Consequently, the minimum amount of lime was used to neutralize zinc sulfate and manganese sulfate. Where zinc sulfate was used, the hydrated lime was

used at a ratio of 1 part of lime by weight to 3 parts of zinc sulfate. Where zinc sulfate and manganese sulfate were mixed in the same spray, the hydrated lime was added at a ratio of 1.1 pound to 3 pounds of zinc sulfate, plus 3 pounds of manganese sulfate or an approximate ratio of 1 to 5. Parathion was used at .5 pounds per 100 gallons in all of the combination sprays. They were applied on pineapple orange trees as dormant sprays and on grapefruit trees as post-bloom sprays.

Satisfactory control was obtained in all of the plots where the dormant combination sprays were applied (See Table 1). Six weeks after the dormant combination sprays had been applied there was an average reduction of 89 percent of infested leaves compared to a 58 percent reduction where an oil emulsion had been applied, and a 42 percent increase of infested leaves in the unsprayed plots. Satisfactory control was also obtained with the parathion in combination sprays at post-bloom time. A 93 percent reduction of leaves infested with purple scale was obtained where parathion was included in a combination spray containing a neutral copper, zinc sulfate, lime, borax, Neotran and wettable sulfur. Such a combination would not be practical with an oil emulsion. In the same experiment, where a combination copper-oil emulsion at 1.3 percent actual oil was used, the infested leaves were reduced 84 percent. In August or about 5 months after the spray another examination of leaves was made and the degree of reinfestation was about the same in plots where parathion was used as in plots sprayed with an oil emulsion.

*Timing.* Definite recommendations for the timing of parathion sprays for scale control cannot be made at this

TABLE 1  
CONTROL OF PURPLE SCALE WHERE PARATHION WAS COMBINED WITH OTHER  
MATERIALS USED AS SPRAYS ON CITRUS

Materials in Pounds per 100 Gallons Parathion Expressed as Active Ingredients Sprays Applied February 6, 1948	Percent Decrease Of Infested Leaves After Sprays		Percent Fruit Infested at Stem-End
	6 Weeks	21 Weeks	28 Weeks
Parathion .3, wettable sulfur 10	79	64	25
Parathion .4, wettable sulfur 10	91	70	10
Parathion .5, wettable sulfur 10	98	83	9
Parathion .5	95	89	10
Parathion .5, wettable sulfur 10 DN 2/3 <sup>1</sup>	87	57	5
Parathion .5, zinc sulfate 3, lime 1, wettable sulfur 10	81	64	9
Parathion .5, basic copper 3 <sup>2</sup> , wettable sulfur 10	98	58	22
Parathion .5, basic copper 3, wettable sulfur 10	88	6	6
Parathion .5, basic copper 3, neutral zinc 2, wettable sulfur 10	96	88	•
Parathion .5, zinc sulfate 3, manganese sulfate 3, lime 1.1, wettable sulfur 10	87	52	11
Oil emulsion (1.3% actual oil in dilute spray)	58	77	25
No treatment	+42		56

<sup>1</sup> DN=40% dinitro-o-cyclohexyl phenol.

<sup>2</sup> No record.

<sup>3</sup> Basic copper=34% metallic copper.

time, but results obtained to date indicate that for seasonal control the summer applications were the most satisfactory. By October 1 there was a higher percentage of infested leaves where either a dormant or a post-bloom parathion spray had been applied than on plots sprayed between June 28 and August 31. Excellent control of purple and red scale was obtained with 0.5 lb. of parathion plus 10 lbs. of wettable sulfur per 100 gallons where this was applied on duplicate plots on June 28, August 2, and August 31, respectively. Adjacent plots were sprayed with an oil emulsion (1.3 percent actual oil) on the same dates, but the control of scale on those plots was not as satisfactory as where parathion was used. (See Table

2). Whitefly control was somewhat more satisfactory where the applications were made on either August 2 or August 31 than where they were made on June 28.

Apparently the timing of parathion sprays will not delay the degreening of fruit since grapefruit from trees sprayed with parathion generally colored sooner than fruit from oil-sprayed trees. In one experiment a set of duplicate plots was sprayed with parathion on October 1, and another set of plots was sprayed with an oil emulsion. On October 4, or 3 days later, samples of fruit were picked and placed in the coloring room. After 54 hours in the coloring room, 94 percent of the fruit was well to fairly well colored from the parathion sprayed plots com-

TABLE 2

TIMING EXPERIMENTS ON GRAPEFRUIT WITH PARATHION AND OIL. EMULSION IN RELATIONSHIP TO THE CONTROL OF PURPLE SCALE, FLORIDA RED SCALE, CLOUDY-WING, WHITEFLY AND DEGREENING OF FRUIT  
All Figures are Expressed in Average percent of Duplicate Plots

Insecticides	Spray Dates	No. Days Between Sprays and Post-Spray Counts	Purple Scale				Florida Red Scale		Whitefly	Degreening Fruit	
			Infested Leaves		Increase or Decrease	Infested Leaves Before Spray	Increase or Decrease After Spray	Well to Fairly Well Colored		54 Hrs. in Room	in 74 Hrs. in Room
			Before Spray	After Spray							
Parathion .5 lbs. Plus Wettable Sulfur 10 lbs. — 100 Gallons	June 28	99	6.5	.5	— 92	.6	.2	— 67	6.0	99	100
Oil Emulsion 1.3% Actual Oil	June 28	99	11.8	20.8	+ 76	4.1	2.6	— 37	4.0	88	97
	Aug. 2	64	29.3	.5	— 98	10.1	.2	— 98	1.0	97	100
Parathion	Aug. 2	64	20.3	19.8	— .2	5.3	1.1	— 79	1.3	81	97
Parathion	Aug. 31	35	61.4	.1	— 99	8.6	.2	— 98	.6	74	90
Oil emulsion	Aug. 31	35	41.6	5.2	— 88	6.3	.5	— 92	.6	83	92
Parathion	Oct. 1	20	52.8	2.5	— 95	11.7	1.1	— 91	1.6	92 <sup>1</sup>	98
Oil emulsion	Oct. 1	20	65.0	25.1	— 61	14.6	5.5	— 62	1.5	46 <sup>1</sup>	68
No Treatment		99	26.0	55.2	+ 53					79	94

<sup>1</sup> Picked 3 days after treatment.

pared to 46 percent colored to the same degree from the oil sprayed plots. At the end of a 72-hour period in the coloring room only 68 percent of the oil sprayed fruit had colored (See Table 2).

The relationship of the timing of parathion sprays to the percent soluble solids in fruit has not been definitely determined, but according to some unpublished preliminary data of J. W. Sites<sup>1</sup> there was no indication that parathion prevented the formation of maximum solids where it was applied in June, August, or October.

It seems possible that parathion may be used at any time of the year as far as any effect on the tree is concerned. However, until more information is obtained, it is advisable not to spray trees with fruit on them. Where the fruit has been picked, a dormant application may be made. This should be followed with a 1.3 percent oil emulsion spray during the summer or parathion may be used again if it is found that it can be applied with

safety. Experimentally, a heavy infestation of purple scale was reduced to a minimum where parathion was combined with compounds of zinc, copper, and wettable sulfur in a post-bloom spray and followed in July with a parathion-wettable sulfur spray.

*Purple Mite* control with parathion was not as satisfactory as with some other miticides now in use. It killed a high percentage of the active mites, but reinfestation occurred within a short period of time after the application. Four days after a February spray was made, only a few purple mites were observed, but within 17 days reinfestations were apparent in 6 of the 7 plots where no other miticide was used. The period of control was much longer where either DN or Neotran was included in the spray or where an oil emulsion was used (See Table 3). A November application of parathion was not as effective as the sprays applied in February. In the November experiment there was a higher percentage of infested leaves when the sprays were applied than existed in Feb-

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TABLE 3  
PURPLE MITE CONTROL ON PINEAPPLE ORANGES  
FIGURES EXPRESSED PERCENT OF INFESTED LEAVES  
SPRAYED FEB. 6, 1948

Materials per 100 Gallons Parathion Expressed as Active Ingredients	Pre-Spray		Post Spray	
	1-22	2-10	2-23	3-13
Parathion .3 lbs.—W. Sulfur 10 lbs.	12.5	2.5	6.3	15.0
Parathion .4 lbs.—W. Sulfur 10 lbs.	6.2	0	13.8	10.0
Parathion .5 lbs.—W. Sulfur 10 lbs.	8.8	0	12.5	34.0
Parathion .5 lbs.	6.3	0	8.8	13.0
Parathion .5 lbs.—W. Sulfur 10 lbs. DN 2/3 lbs.	16.3	0	1.3	5.0
Parathion .5 lbs.—W. Sulfur 10 lbs.—Neotran	13.8	0	0	6
Parathion .5 lbs.—Copofilm 3 lbs.—W. Sulfur 10 lbs.	25.0	2.5	21.0	24.0
Parathion .5 lbs.—ZnSO <sub>4</sub> 3 lbs.—MnSO <sub>4</sub> 3 lbs.— Lime 1.1 lbs.—W. Sulfur 10 lbs.	20.0	0	0	4.0
Oil Emulsion 1.3% Actual Oil	20.0	0	2.5	9.0
No Treatment			53.1	44.0

ruary which may have been a factor in the lower percentage of control. However, the control obtained with either DN or Neotran was more satisfactory than where parathion was used. (See Table 4).

*Rust Mites* were killed with parathion but the periods of control were of short duration. Nine days after the application there was a definite reduction, but within 24 days the trees were reinfested to a marked degree as compared with the slight reinfestation where wettable sulfur was used (See Table 4).

*Other Insects.* Cloudy-winged whitefly was controlled with parathion to about the same degree as with an oil emulsion. Neither of the June 28 applications of parathion or oil emulsions was

as effective as August 2 and August 31 applications (See Table 2).

Citrus mealbug infestations were effectively reduced. On April 19 an application of parathion at .5 pounds per 100 gallons was made on 5 orange trees. At that time 100 percent of the fruits examined were infested with mealybugs under the calyx. On June 9 when the final examination was made, 98 percent of all fruits within reach were free of mealybugs on the sprayed trees as compared to 2 percent of mealybug-free fruit on 10 untreated trees on each side of the sprayed ones. On the sprayed trees, the spring flush of foliage was free of "sooty mold" which also indicated the absence of mealybugs while there was an abundance of it on the unsprayed trees. On

TABLE 4  
PURPLE MITE AND RUST MITE CONTROL.  
SPRAYED NOVEMBER 14, 1947  
Figures Express Percent Infested Leaves

Dilutions = Pounds per 100 Gallons	Pre- Spray	Purple Mite			Rust Mite			
		Nov. 25	Dec. 19	Jan. 22	Pre- Spray	Nov. 25	Dec. 19	Jan. 22
Parathion 2.6	9	6	10	27	56	8	43	16
Parathion 2.0	10	9	26	26	58	5	39	34
Parathion 2.0	26	2	24	31	43	5	35	17
Toxaphene 2.65	41	3	16	43	60	11	29	30
Neotran 2.0	48	2	5	8	70	4	88	20
Neotran 2.5	11	0	0	4	55	10	47	12
Neotran 2.0	1	0	0	1	45	1	12	1
W. Sulfur 10.0								
Neotran 2.5	1	0	0	2	52	3	4	2
W. Sulfur 10.0								
DN .66	2	0	1	3	50	12	41	24
DN .66	55	0	0	2	46	1	7	6
W. Sulfur 10.0								
W. Sulfur 10.0	15	20	35	51	48	2	19	3
No Treatment	9	9	13	17	42	59	92	87

Parathion = 25% wettable  
W. Sulfur = 90% Wettable Sulfur  
Toxaphene = 33% Wettable Chlorinated  
Camphene

DN = 40% Wettable dinitro-o-cyclohexyl  
phenol  
Neotran = 40% bis(P-chlorophenoxy) meth-  
ane

grapefruit, trees, which were sprayed on June 28 the control was not quite so satisfactory where the mealybugs had become massed between fruit hanging in clusters, but the control was much more satisfactory than with an oil emulsion. In connection with mealybug control, it was observed that where parathion was used, all of the pink scavenger worms, *Pyroderces rileyi* Wlsm., were killed. These worms are usually associated with mealybug and sometimes purple scale infestations. The control of these worms would be an additional benefit since they sometimes eat into the peel of the fruit and may cause considerable damage.

Limited tests have been made for the control of cottony-cushion scale, the green citrus aphid and the bird grasshopper (2) and in each case a high percentage of kill was obtained.

It remains to be seen what effect parathion will have on the biological control of insects and mites when whole groves have been sprayed. Where parathion was applied, many dead ladybeetles were observed, but where an oil emulsion spray had been applied on trees in the same block very few dead beetles were found. However, within a week after the application, living beetles were observed on the parathion sprayed trees. The results to date indicate that neither Florida red scale nor purple scale have reinfested citrus trees any sooner following parathion sprays than where an oil emulsion had been applied. The effect on scale parasites has not been determined, but apparently the parathion residue dissipates in a few days, and it seems unlikely that it will have the same residual effect in scale parasites that DDT has. Griffiths and Stearns (1) reported that appreciable amounts of DDT

were recovered from leaves 4 weeks after an application; whereas, the results of recent experiments indicate that 80 to 90 percent of the parathion had dissipated in about three days during warm weather.

*Residue Studies.* In a limited number of analyses made of parathion residue on leaves, it was found that during warm weather a high percentage of it disappeared in a few days. On October 1, an application was made of parathion at .5 pound per 100 gallons on orange trees. A sample of leaves was collected after the spray had dried and on each of the 3 succeeding days samples of leaves were collected and analyses were made of the residue. Rain fell on the fourth day so no further analyses were made. Three days after the application approximately 90 percent of the parathion had disappeared on outside foliage and 80 percent on inside foliage. Results of other analyses made a month or more after an application showed that a small amount of parathion was still present but it is the opinion of the writers that the amount recovered a month after spraying was parathion which had been absorbed by the leaves and was not a surface residue.

Analyses were made of the juice and peel of Parson Brown oranges to check on the penetration of parathion. On September 18, analyses were made of juice of the oranges picked from trees which had been sprayed on different dates with parathion at 1.0 lb. of the active ingredient per 100 gallons. Where the spray had been applied on the respective plots on March 15, April 1, June 1, and July 1, no trace of parathion was found. However, a trace was found in the juice of fruit from trees sprayed on May 1, August 1, and September 1.

On October 13, analyses were made of the peel of the Parson Brown oranges from the respective plots. No trace of parathion was found in the peel where the spray was applied on March 15, which was during the period of petal fall, but amounts ranging from 0.3 to 2.0 parts per million were recovered in the peel where the spray was applied on successive plots the first of each month from April 1 to September 1, inclusive (See Table 5).

One series of analyses was made of the juice and peel of grapefruit that had been sprayed with parathion at .5 pounds per 100 gallons on April 6 or approximately 3 weeks after the fruit had set. On September 28 the juice was analyzed and on October 19 an analysis was made of the peel for parathion. No parathion was found in the juice but small amounts ranging from 0.1 to 0.3 ppm were found in the peel. In one plot which had been sprayed on August 2 with parathion at 0.25 pounds per 100 gallons, there was 0.8 ppm in the peel.

It has not been determined, as yet, whether the small amount of parathion found in the peel may get into the juice when the fruit is processed. Before any recommendations can be made by the Citrus Experiment Station repeated tests must be made for the presence of parathion in the juice and peel of fresh and processed fruit. Additional information

is also necessary in regard to concentrations, compatibility with other materials, effect on predators and parasites, and the effect on the trees under various weather conditions.

*Summary.* Parathion killed Florida red scale and purple scale in concentrations varying from 0.15 to 0.5 pounds of the active ingredient per 100 gallons. It was effective for scale control when combined in sprays with neutral compounds of zinc and copper, wettable sulfur, and borax. The toxicity of parathion did not appear to be seriously affected where the minimum amount of lime was used to neutralize zinc sulfate and manganese sulfate. The longest period of control of scale insects was obtained where the sprays were applied in either June, July, or August. No relationship was found between the timing of parathion in either the degreening of fruit, formation of maximum solids in the juice of fruit, or shock to the trees. The active stages of purple mites and rust mites were killed, but the period of control was of short duration. Parathion was found to be toxic to mealybugs, cottony-cushion scale and ladybeetles.

The residual effect of parathion on the leaves was of short duration. Zero to a trace of parathion was found in the juice of oranges and grapefruit, but slightly more was found in the peel.

TABLE 5  
AMOUNTS OF PARATHION FOUND IN THE JUICE AND PEEL OF PARSON BROWN ORANGES  
FOLLOWING SPRAYS CONTAINING 1 POUND OF THE ACTIVE INGREDIENT PER 100 GALLONS

		Spray Dates						
		Mar. 15	April 1	May 1	June 1	July 1	Aug. 1	Sept. 1
Parts per	Juice	0.0	0.0	0.02	0.0	0.0	0.01	0.01
Million	Peel	0.0	0.3	2.00	1.0	0.7	2.0	2.0

Dates of analyses, Juice, September 18; Peel, October 13.



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## RECENT EXPERIMENTS ON MELANOSE CONTROL WITH REFERENCE TO ORGANIC FUNGICIDES AND DORMANT SPRAYS

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During the past 5 years numerous new organic fungicides have been developed. Many of these have given excellent control of diseases on tomatoes, potatoes, apples, cherries, peaches, grapes, and other crops. Voorhees (3) reported that

satisfactory for melanose control. Since Fermate and Spergon did not give satisfactory control of melanose while Miller (1) also reported that Fermate was un-1946, some of the organic fungicides have been included in the melanose control experiments each year.

The performance of the organic fungicides with regard to melanose control has not been as good as was expected from their effectiveness for the control

TABLE 1— A COMPARISON OF THE EFFECTIVENESS OF ORGANIC AND COPPER FUNGICIDES FOR MELANOSE CONTROL.

Material <sup>1</sup>	Lbs. per 100 Gals.	Percent No. 1 Fruit		
		1946	1947	1948
Copofilm	2.2	89.3		
C II copper oxide	1.0		72.7	
Copper compound A	1.7	82.8	71.7	
Tribasic copper sulfate	1.5	86.2		
Dodge-Phelps basic copper sulfate	1.5	88.4		
Bordeaux mixture	3-3	83.1	60.5	96.2
Copper-8-quinolate	1.0	56.5		
No. 341, 2-heptadecylglyoxalidine	2.5	63.5	9.8	
Parzate	2.0		44.1	
Zerlate	2.0			78.8
Manganese ethylene bisdithiocarbamate	2.0		21.3	
Nonsprayed		7.8	10.6	12.2

<sup>1</sup>Sprays applied. April 1, 1946; April 28, 1947; April 2, 1948. Data recorded: December 23, 1946; December 29, 1947; October 7, 1948.

Wettable sulfur 10-100 added to all sprays for rust mite control.

of certain diseases of other crops. As is indicated in Table 1, all of the organic fungicides tested were inferior to the copper fungicides for melanose control on grapefruit. The final results of the 1948 experiment have not been recorded but sufficient data were obtained so that the performance of Zerlate could be included in this report.

There are two possible reasons why the organic fungicides were not as effective as had been expected. Organic materials, both insecticides and fungicides, are often quite specific. A material will be very toxic to one organism and not to another. Further, since only one spray application was applied, the organic fungicides might not remain active over as long a period of time as do copper fungicides. Since a copper material functions as a nutritional as well as a fungicidal spray, it will be difficult for an organic material to be as effective in the over-all program of grove management.

Although Ruehle and Kuntz (2) have shown that the dormant application of a copper fungicide did not give satisfactory control of melanose, it was

thought advisable to obtain additional data on this point. If a reasonable control of melanose could be obtained by adding the copper fungicide to the dormant spray, the after-bloom application might be eliminated and thus reduce the cost of production during periods of low price fruit.

Experiments were conducted in 1946 and 1947 and the data are presented in Table 2. The dormant application of a copper fungicide resulted in an unsatisfactory control of melanose on grapefruit. The crop of fruit from the trees receiving a dormant application of a copper fungicide showed excessive melanose and would definitely not be acceptable for the fresh fruit market and might not be usable at the canning plant. It is advisable to apply the fungicide according to the standard recommendations to obtain satisfactory melanose control; that is from 1 to 3 weeks after the fruit has set.

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TABLE 2--A COMPARISON OF THE EFFECTIVENESS OF DORMANT AND POST-BLOOM FUNGICIDE APPLICATION FOR MELANOSE CONTROL.

Year	Grove Pruned	Date Application <sup>1</sup>	Percent No. 1 Fruit
1946	Yes	Feb. 18	50.3
1946	Yes	April 1	89.3
1946	Yes	None	7.8
1947--No. 1	No	Feb. 21	24.0
1947--No. 1	No	April 28	71.7
1947--No. 1	No	None	10.6
1947--No. 2	Yes	Feb. 22	34.6
1947--No. 2	Yes	May 1	74.8
1947--No. 2	Yes	None	45.4

<sup>1</sup>Spray applied composed of copofilm 2.2 lbs. and wettable sulfur 10 lbs. to 100 gallons.

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## A COMPARISON OF ORGANIC AND COPPER FUNGICIDES FOR CONTROL OF MELANOSE OF CITRUS FRUITS

(A summary)

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Deposits of road dust, and the inert ingredients of fungicides and insecticides have long been recognized as favorable to the increase of scale insect populations on citrus foliage. Although many of the organic fungicides are characterized by lighter deposits than the older inorganic fungicides, they have been found more specific in their toxic action towards various fungi. This specificity, at least of the organic fungicides tested, has not been reported previously to include toxicity for the organism (*Phomopsis citri*) that causes melanose.

Eight organic fungicides were selected for trial on the basis of their effective control of other crop diseases, and were compared with three copper fungicides for control of melanose on Marsh and Duncan grapefruit trees in three experiments. In general, the concentrations for 100 gal. of water were those recommended by the manufacturer and were as follows for each of the eight materials: (1) disodium

ethylene bisdithiocarbamate (D-14) 1½ lb., ZnSO<sub>4</sub> 1 lb., Ca(OH)<sub>2</sub> ½ lb.; (2) dichloro naphthoquinone (Pygon) 2 lb., Vatsol O.T. 5/10%; (3) 2,2-dihydroxy-5,5'-dichloro diphenylmethane (Preventol G.D.) 1½ lb., ZnSO<sub>4</sub> 1 lb., Ca(OH)<sub>2</sub> ½ lb.; (4) 2-heptadecyl glyoxalidine (No. 341) 2 qts., Ca(OH)<sub>2</sub> 3 oz., Vatsol O.T. ¼%; (5) hydroxyethyl a-heptadecyl glyoxalidine (No. 337) 1 lb., wettable sulfur 5 lbs. (6) ferric dimethyl dithiocarbamate (Fermate) 1 lb., Vatsol O.T. 5/100%; (7) 8-hydroxyquinoline sulfate 13 lb.; (8) polyethylene polysulfide 2½ lb. For comparison the following copper compounds were used as follows: (1) copper 8 quinolinolate 1½ lb., ZnSO<sub>4</sub> 1 lb., Ca(OH)<sub>2</sub> ½ lb., Vatsol O.T. ¼%; (2) tetra-copper calcium oxychloride (Copper A) 1½ lb., DuPont wetter 4 oz.; and (3) Bordeaux mixture, 6-4-100.

From 6 to 8 trees were sprayed with each treatment, 45 days after full bloom, on the average. Fruits (50) from each tree were graded individually, according to Ruehle's<sup>1</sup> scale of rind blemishing in which 0-10 spots per square inch=very slight melanose, 11-25=slight, 26-50=moderate, and 51+=severe; the results were averaged for each treatment.

The three 6-4-100 Bordeaux treatments gave outstanding control, with average melanose infection as follows: (a) very slight, 55% of the fruit crop; (b) slight,

<sup>1</sup> Ruehle, Geo. D., and Wm. A. Kuntz. Univ. of Fla. Agr. Exp. Sta. Bull. 349. Melanose of citrus and its commercial control. 1940.

35%; (c) moderate, 9%; and (d) severe, 1%. The three unsprayed checks averaged as follows on the same scale (a) 8%, (b) 27%, (c) 26%, and (d) 39%.

Copper A compound gave practically as good control as the Bordeaux spray. Copper 8 quinolinolate gave a degree of control intermediate between the Bordeaux spray and the checks. The fruits

sprayed with seven of the organic compounds were not distinguishable from the unsprayed checks, except that polyethylene polysulfide seemed to increase melanose blemishing.

The above results indicate that none of the organic compounds tested offer any promise as substitutes for copper in controlling melanose of citrus.

## RECENT DEVELOPMENTS IN FLORIDA PEACH PRODUCTION

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Interest in peach growing in Florida has existed for many years and numerous varieties have been tested. It was discovered that the only varieties which could be grown successfully in the State were those which required little cold weather to cause flowering and subsequent fruit set. Such varieties were found in the Peen-to and South China races, and many trees of these have been planted during past years to give fruit for home use and limited commercial production.

Fortunately there are a few varieties which can be grown in Florida with the mild temperatures which exist. Several of these can be selected according to ripening dates so that ripe fruit can be had for home use over a longer period of time during the early spring and summer than if only one was planted. However, because of the heavy production in Georgia and South Carolina, only

peaches which will mature fruit that can be marketed prior to heavy movements from these areas have a place for commercial production in Florida. The Jewel is best for this purpose since it will mature its fruit sufficiently early in most years to provide ripe fruit before heavy shipments begin from other states.

The Jewel was introduced in 1892 by T. K. Godbey of Waldo, who selected it from a planting of Waldo seedlings. It is a variety belonging to the Peen-to race with average ripening dates of May 10 to 20, but in some years they will be earlier or later than these, depending on weather conditions in the spring. The fruit is freestone, medium in size which can be increased by thinning the crop, rounded to oblong; creamy color, splashed with red; flesh whitish but red about the pit, juicy and of good quality and character; flavor, sweet and pleasing. When the fruit is properly grown, harvested and handled, it generally can be readily sold on local and out-of-State commercial markets.

Recommendations for planting peaches in Florida have emphasized the necessity of setting trees on newly cleared land to use plum stocks to prevent

losses from root-knot nematodes. It is not always possible to have available such newly cleared land for planting the peach orchard, even though it is the only safe place to set trees, except in certain locations about the home where nematodes are not quite so abundant. There are now several chemicals and treatments that seem to be promising in helping to overcome this problem. If they do work satisfactorily in reducing nematode injury, it will then be possible to use land which has previously been in cultivation.

Since the introduction of chemicals that will kill nematodes, extensive investigations have been conducted with them as soil fumigants where peaches were to be planted. Most of this work has been done in other States but some work has been conducted in Florida. At Tifton, Georgia, the Coastal Plains Experiment Station has conducted numerous tests using different chemicals for treating the soil prior to planting the peach trees. These workers, as well as others, have made treatments using various amounts of the different chemicals injected into the soil at different depths.

In order to test the effects of soil fumigants on nematodes in Florida soils, two experiments are being conducted with Jewel peaches. One of these has been going for 2 years and the other for 1 year. In 1946 an experiment was set up at Whitney on the Experimental Farm of the Florida Station's Watermelon and Grape Laboratory at Leesburg. This experiment was set up to study the effects of chemicals in killing nematodes in soil that was known to be heavily infested with rootknot. The chemicals were injected into the soil prior to planting the trees. Treatments included DD, chloropicrin, check and

organic mulch, without a soil fumigant. The fumigants were applied in December 1946, to an area 8 feet in diameter at each tree location. In January 1947, trees of the Jewel variety were planted at all locations, and in the case of the fumigated areas the trees were set in the center of that treated. Native grass and indigo were used as the mulching materials around five of the trees in the unfumigated soil.

During 1947 and 1948 the growth and condition of the trees in all plots were recorded. In both years the growth has been better in the plots treated with fumigants than it was in the untreated check. However, the mulch treatment has been somewhat better than the fumigation in that the over-all growth of the trees has been just as good and this year the trees have held their leaves later than those where no mulch was applied. This presents an interesting situation regarding the use of mulches in various types of peach plantings, and it is being investigated further in the experiment at Gainesville.

Following the results obtained at Whitney in 1947, an experiment with Jewel peaches was set up on the Experiment Station's farm at Gainesville. In this test the treatments include DD, chloropicrin, ethylene dibromide (Dowfume W-40) and check. The treatments were replicated eight times and each plot divided so that half of the trees received a mulch and half were left unmulched. The land was staked off in the usual manner to establish the exact location where each tree was to be planted. The chemicals were applied in a square 9 x 9 feet, at the rate of two cc per square foot, with the tree location in the center of this area. In 1948 the mulch material was blue lupine applied

about the trees in a 3-foot circle, 8 inches deep, early in the spring.

At the end of the first year the average growth of the trees as measured by cross-sectional area of the trunk has been better where the trees were mulched (Table 1). Also, the average effect of soil fumigation was to produce better trees than the check (Table 1). However, the significant interaction of soil treatment with mulch indicates that there is a differential response under the two conditions of mulch. An examination of Table 1 shows that chloropicrin is the superior treatment under the condition of no mulch but it is not benefited by mulching as are the other treatments. When a mulch was employed DD and Dowfume W-40 were the superior treatments.

peaches on lands heavily infested with nematodes such as those used in these tests.

It might at first appear to be a difficult task to mulch where there are several acres involved. It is not such a big job to do this if proper provisions are made for obtaining the materials for the mulch. Cover crops are valuable on the land and these can be utilized to supply enough material to cover the soil about the trees. *Crotalaria*, indigo, lupine and other legumes, as well as nonlegumes such as all kinds of weeds and grasses can be grown between the tree rows and the growth used for mulching the soil about the trees. The easiest way to handle this growth is to cut the material and rake it up toward the tree rows

TABLE 1

EFFECT OF MULCHING AND SOIL FUMIGATION TREATMENTS ON JEWEL PEACH TREES AT END OF FIRST GROWING SEASON, GAINESVILLE, FLA

Treatment	Cross-sectional Area of Tree Trunk in Square Inches		
	Mulched Average of 8 Trees	No Mulch Average of 8 Trees	Average of Mulched and Non-Mulched Trees
Check	0.97	0.47	0.72
DD	1.50	0.63	1.06
Chloropicrin	1.12	1.02	1.07
Dowfume W-40	1.65	0.73	1.19

Least significant difference at 5 percent level for comparing fumigation treatments under each mulch treatment—0.45

Least significant difference at 5 percent level for comparing mulch vs. no mulch for each fumigation treatment—0.39

From these preliminary results it would seem that it will prove of great value in obtaining growth if the soil around young trees is covered with a mulch of some organic material. This will prove helpful in reducing the injury from nematodes and, especially if used in connection with an acceptable soil fumigant, it should be possible to grow

in windrows where it can be readily placed about the trees with pitchforks. It is not necessary to pack the material after it is placed as it will settle in a short time and produce the desired results. It would be advisable to do this mulching each year, as it is necessary for the soil to be kept covered for the mulch to be effective in promoting healthy tree

growth. The material can be placed about the trees at any time when available but, for newly planted trees, the mulch should be applied early in the spring by the time growth starts.

Any one of the chemicals under test can be used for treating the soil prior to planting but the cost of DD and ethylene dibromide is much less than that of chloropicrin. Chloropicrin has some fungicidal value that the other two do not have but the cost is several times that of the others. The chemicals can be applied at the locations where the trees are to be set with a hand applicator or they can be injected with a machine applicator, treating the entire row, or the whole area where the orchard is to be planted. The cost per acre for broadcast application where the entire orchard location is to be treated will vary with the amount of land to be fumigated. Commercial operators do the work under

contract at so much per acre of actual area treated.

With soil fumigation treatments it would seem it should be possible to grow peaches on lands that have been in cultivation long enough to become heavily infested with nematodes. However, it is recommended that an organic mulch be applied on the soil about the trees in connection with the use of soil fumigants as better tree growth is being obtained in experiments where mulches have been applied. Mulching materials can be produced in the orchard by growing either natural vegetation or planted cover crops.

#### ACKNOWLEDGMENTS

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## THE AMERICAN TUNG INDUSTRY TODAY

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The tung oil industry of the United States is based upon the species known botanically as *Aleurites fordii*. This tree has grown for centuries in China and tung oil, obtained by pressing the kernels of its nutlike fruit, has been put to many uses by the Chinese. In this country by far the greatest percentage (75-80) is used in paints and varnishes. Among other uses one might list water-

proofing, electrical insulating, coating tin plate, and making printers' ink.

The first trees in this country were grown from seed received in 1904 by the Division of Plant Exploration and Introduction, of the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture. Subsequent test plantings revealed that the tung tree thrived best in the Southeastern States. It is now grown commercially in an area extending along the Gulf of Mexico from eastern Texas to Southern Georgia and northern Florida.

During the 1920's and early 1930's more tung trees were planted in Florida than any other State, but by 1940 Missis-

<sup>1</sup> Senior Pomologist, U. S. Field Laboratory for Tung Investigations, Division of Fruit and Vegetable Crops and Diseases, Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, Department of Agriculture.

issippi had more acreage than all other States combined. The reasons for extensive plantings in Mississippi were undoubtedly the large acreage of cut-over pine land that was available at low cost and the low development contract prices for absentee owners.

The latest data available reveal that this comparatively young industry now comprises approximately 12 million tung trees growing on nearly 175,000 acres of land in six States. Tung production records of 1939-47 inclusive in the six States are presented in Table 1. It can be seen that production is increasing in all of the States and that total production in the United States has increased from 1,160 tons of air dry fruit in 1939 to an estimated 66,700 tons in 1947, from which was expressed approximately 25 million pounds of tung oil. The 1948 crop has been estimated roughly at 85,000 tons. It is also seen that since 1941 Mississippi has produced more than any other State with the exception of 1943, when late spring frosts caused more serious damage to the crop in Mississippi than in Louisiana. The average percentages of the crop produced by the several States during the past 4 years are Mississippi 41.6, Louisiana 27.8, Florida 24.7, Georgia 3.0, and Alabama 2.9.

Finally, the data in Table 1 show that substantial domestic production of tung oil began about the time that imports from China were restricted by the war. In 1942 a rather liberal price ceiling was established, in order to promote the production required by our government for military purposes. Under these conditions tung growing was very profitable, at least for those growers who owned bearing orchards on good soil and who were giving the trees good care.

However, in 1947, growers found that due to the scarcity of tung oil during the war, the paint manufacturers, who normally use 70 to 80 percent of the tung oil produced, had turned to substitute oils. Some are now reluctant to return to their old formulas even though liberal supplies of tung oil are now available at moderate prices. Inflation and the demand for U. S. dollars have created a situation that has made it desirable for China to export tung oil and sell it in the United States at prices considerably below the ceiling price that the American tung growers had become accustomed to. For these reasons the market dropped from 38 cents per pound of oil in January 1947 to 21 cents per pound in August 1948. The 1947 crop had a government support price of 25 cents per pound. The large 1948 crop has no support price and as a result there is much anxiety among the growers. There is real distress, too, because the growers' operating costs have increased 30 percent or more, at the same time that their selling price has dropped to about 55 percent of the wartime ceiling.

This is not the first time that the tung industry has faced problems. Except for research conducted by the Florida Agricultural Experiment Station tung growing in the United States would probably have "died aborning." Mowry and Camp (1) and Reuther and Dickey (2) diagnosed and recommended remedial treatments for zinc and manganese deficiencies that were widely prevalent and that threatened to wipe out the young tung trees. Again in 1948, research by Federal and State agencies has pointed the way to reduced costs of production, and thus in spite of the present difficulties, the long range outlook for the industry is good.



As a result of nutritional and cultural studies, it is now possible through proper soil management and fertilization to increase yields of established orchards on suitable soil far beyond the most optimistic hopes of 10 years ago. Yields of 1 to 3 tons per acre are now obtained. Special studies have made it possible to recognize and recommend treatments for magnesium, copper, potassium, and nitrogen deficiencies. They have also led to a recognition of the fact that not only the rate of fertilization but also the balance between nutrient levels is very important. It should also be mentioned here that foliar analysis has proved to be a very valuable test and guide in nutritional studies and has helped return maximum information per dollar of research funds expended.

New tung plantings may now be made with confidence that yields will be higher and production costs lower than in present bearing orchards, because much more is now known about where and what to plant. The results of soil studies quickly revealed that tung trees thrive only on well-drained, fertile soils. As a result one can now plant intelligently, without risk of failure due to unsuitable soil type.

New varieties have been propagated vegetatively from outstanding individual parent tung trees, and certain parent trees have been found that produce rather uniformly satisfactory seedlings. That these trees bear more heavily than average nondescript seedling trees has been recognized by the tung growers, as is evidenced by the fact that they have planted hundreds of thousands of these U.S.D.A. selections in recent years.

In the past loss of crop and trees from frosts and freezes has been a major concern of tung growers. While much re-

mains to be accomplished in protecting the industry from these losses, nevertheless, some progress has been made in the selection and breeding of varieties that appear less subject to cold damage than others. It has also been observed that, as in the case of other crops, cold damages well fertilized trees less than neglected ones; and because an improved fertilizer program is now followed throughout the industry the recent losses from low temperatures have been much lower than formerly.

#### THE FUTURE OF THE TUNG INDUSTRY

Accordingly, it is felt that the tung industry will survive the present crisis brought on by low prices and will continue to expand. Recent advices indicate that some paint and varnish manufacturers are turning back to tung oil, even though its use entails certain technical difficulties not encountered with other drying oils. This trend is attributed to a better appreciation of the high quality of paints made with a tung-soy vehicle, and to the present relatively low cost of tung oil. By taking advantage of the results of recent research growers can in some instances double their yield per acre thus materially lowering the cost of production per pound. It also appears likely that harvesting operations may soon be largely mechanized, which will greatly reduce production costs. With efficient production the domestic tung grower can successfully meet world competition in a normal market.

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TABLE 1

TUNG NUTS: PRODUCTION OF DRIED TUNG FRUIT IN COMMERCIAL STATES, 1939-1947<sup>1</sup>

Season	Miss.	La. <sup>2</sup>	Fla.	Ga.	Ala.	Total 5 States
	Tons	Tons	Tons	Tons	Tons	Tons
1939	425	150	550	15	20	1,160
1940	3,700	1,200	4,700	1,200	200	11,000
1941	3,700	1,800	2,250	650	350	8,750
1942	7,200	4,000	3,700	950	500	16,350
1943	1,940	3,260	700	200	100	6,200
1944	10,630	7,550	7,000	800	700	26,680
1945	15,690	10,750	8,400	1,100	1,140	37,080
1946	23,800	15,200	15,000	1,800	1,600	57,400
1947 <sup>3</sup>	28,000	18,700	16,000	2,000	2,000	66,700

<sup>1</sup>These data were released by the U. S. D. A. Bureau of Agricultural Economics, Orlando, Florida, under date of January 26, 1948.

<sup>2</sup>Includes small quantities of tung nuts produced in Texas.

<sup>3</sup>1947 estimates of production are preliminary.



# VEGETABLE SECTION



# FEDERAL RESEARCH ON VEGETABLES IN THE SOUTH

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## FEDERAL WORK IN THE SOUTH LARGELY COOPERATIVE

In the time to which I am entitled here, it is necessary to restrict my remarks to that part of Federal research on vegetables with which I happen to be intimately associated—the work of the Division of Fruit and Vegetable Crops and Diseases in the Bureau of Plant Industry, Soils, and Agricultural Engineering.

First of all, I want to make clear that in our efforts to help Southern vegetable growers with their production problems, we do not work alone. Nearly all of our work is done by Federal and State men working together under one kind of arrangement or another. When I say “we” I refer, in most instances, to those partnerships. Many Federal reports on vegetable research in the South in recent years have been published by Federal and State men jointly. Our men appear also as joint authors of the publications of many State experiment stations. That is good. That is the best way for us to work.

These joint activities, however, have their difficulties as well as their advantages for all concerned. I feel that too often there has been a tendency for some groups in all parts of the country to overlook the importance of their own State research agencies when they go forth to seek help in solving their technical problems. Sometimes, but not

often, Federal agencies are asked to deal with some problem that is of such a local character that it is more properly a responsibility of a State alone. There are so many difficult, region-wide problems that really *require* Federal assistance—notice that I said *assistance*, not *solution*—that we should not become involved in matters of small scope.

My main concern at this point, however, is with the seeming belief among some groups that only the United States Department should be expected to undertake the solving of certain problems in some State or group of States. Again and again troubled segments of the industry have made representations to Washington that have resulted in the assignment of Federal research men to work in cooperation with State Experiment Stations on a problem, only to find that they had neglected to support their own State stations enough to enable them to work effectively with us. The State agencies want, and need, to be able to join forces with us on a really substantial basis just as much as we want them to. A badly mismatched team is neither so effective nor so happy as one that is fairly well matched. Sometimes the State institutions are in the embarrassing position of having virtually nothing that they can assign to an intended cooperative investigation. When either side of a State-Federal arrangement has to feel that it is not able to do its reasonable share on a job, it is in a difficult situation. I know, because our own staff is on the skimpy side of certain arrangements. In our efforts to be helpful to as many States as possible, we

sometimes tend to spread our resources too thin for maximum effectiveness.

I believe that if either the Federal or the State side is disproportionately strong, both together will accomplish less than if the same total resources are better balanced between the two. Yes, this is a plea for better State support of experiment stations, in order that they can work more effectively with us, thereby making our own efforts and the joint efforts more productive. These disparities are being reduced gradually in various areas, but there is still a long way to go.

I want to describe for you in some detail how one of our major projects is operated in the South because it is a good illustration of what we can do together, and also why we need strong institutions both State and Federal, if agricultural research work is to pay off as it should.

#### THE REGIONAL VEGETABLE BREEDING LABORATORY

The first regional laboratory established under the Bankhead-Jones Act of 1935 was the U. S. Regional Vegetable Breeding Laboratory set up in 1936 at Charleston, S. C. One reason why that station could be established was that the directors of the 13 Southeastern State Experiment Stations appreciated the plight of the vegetable industry in those States. They realized that the industry always had been compelled to try to get along with varieties that were not well adapted to the South, varieties that had been developed in other parts of the country and were generally better adapted to other parts than to the South. Vegetable varieties bred in and for the South were needed.

The Southeastern directors and department leaders set up the broad objec-

tives and the cooperative framework within which we were to work. Then the men responsible for the vegetable research in those 13 States and in the Bureau, got together in Charleston, mapped out the way the laboratory could be of the greatest long-range value to the region, and even determined six specific problems that would be undertaken at the start.

It was obvious that although the Charleston area represented a good *average* for the climate and soils of the vegetable districts of the Southeast, some States—Florida and Texas particularly—had conditions like no other areas in the Southeast. Therefore, it was equally obvious that the laboratory should not try to do entirely finished jobs of breeding new varieties that would suit the whole Southeast. The laboratory was given the main job of collecting and testing all possibly promising varieties and wild forms of a given crop that might be used as parents in breeding new varieties that will be resistant to specific troubles, more productive, of higher quality, and otherwise superior to the varieties already available. These parent materials are exhaustively tested against diseases, heat, cold, and other factors. Large numbers of crosses are then made among parents having various superior characters. The offspring of these crosses are subjected to careful selection for several generations to get rid of the obviously inferior and non-superior individuals.

Now here is the most important and significant part of the whole plan: After these new hybrid offspring are selected for a few generations to get rid of most of the obviously worthless material in them, *large numbers of them are sent to the cooperating State workers for testing*

*and further selection to make sure they fit the requirements of the different States or subregions within the Southeast.* If final selections were attempted at Charleston for all these breeding lines before sending them out, we would certainly make the mistake of saving too many lines having only limited adaptability—fine at Charleston but not in many other places. We would also probably discard lines that failed to make the grade at Charleston but which might be outstanding in Florida, Texas, or elsewhere.

Will this plan work? It will if we work it. It has worked beautifully in your own State. For example, your own men have taken unfinished material from Charleston—breeding lines of beans that were still breaking up but which had the desired qualities in them. Your men at Belle Glade soon selected out of them varieties that your growers were eager to have—Florida Belle and Florida White Wax. But there is just one catch in this nice plan. The State workers can not take advantage of the flow of material from Charleston, for the benefit of their respective special conditions, unless they have the resources to grow, to study, select, and test large numbers of breeding lines in their respective areas. Through no fault of the State Experiment Station workers themselves, they have been generally unable to take full advantage of the plans we worked out together. In the last 2 or 3 years, however, the fortunes of a number of them have improved so that they can do more than in the past. Naturally, some breeding lines look so very good at Charleston that they are carried to completion there, and are released for commercial use if the numerous tests indicate they are widely adapted.

All State collaborators and our own staff get together about once a year at Charleston to go over work in the field, compare data, evaluate results, correct errors, and plan another season's work. There are additional contacts among many of the men during the year. At present work is in progress on beans, peas, tomatoes, watermelons, cabbage, and sweet corn.

The foregoing outline shows the practical part of the laboratory job and how it works. There is another less spectacular, less popular, but no less important part. It is not sufficient merely to stumble onto some lucky combination that ultimately turns out to be a good variety. That is fine, as far as it goes. But we need to know the hereditary make-up of the parents we use, need to know how resistance to this or that disease is inherited, how specific qualities and properties are inherited. All manner of technical methods and principles need to be devised if we are to work at a high level of efficiency and with speed. Without such knowledge and methods we can make some progress but only slowly and inefficiently. The importance of this phase of plant breeding is little understood by the general public, even the agricultural public, and we are sometimes condemned for spending our time on it. Without it, however, we would be able to make no faster progress in plant improvement than would a gardener of the Middle Ages. Modern problems require modern tools. We can not afford to depend entirely on luck and guesswork.

Enough of why and how we work together, and how we should be able to work together. You are mainly interested in what we are doing.



### SWEETPOTATOES

Jointly planned and executed studies on several sweetpotato problems in the past 10 years have added important new knowledge of the crop that no one State could have obtained by itself, and which Federal workers could not have obtained alone with the resources at our disposal. A number of joint publications have been issued.

Using much the same principles as those set forth for the Vegetable Breeding Laboratory, a large breeding program is now in progress. It has the double-barreled objective of producing higher yielding, disease-resistant, higher quality varieties for (1) feeding and industrial use, (2) table use. Two feed and industrial varieties have already come out of the work: The Pelican Processor originating in Louisiana and Whitestar originating in Maryland. These are very high-yielding, wilt-resistant, white-fleshed varieties with high solids content and high yields of starch per acre. We also have on hand high-yielding seedlings of this type that are far more tolerant to wet soils than most varieties and that appear suited to delayed harvest in Florida, for feed or starch making. Ultimate success of the industrial type of sweetpotato is dependent largely upon improved mechanization of crop production; but we already have obtained through breeding some varieties of outstanding yielding ability and content of solids.

Producing improved table varieties is more difficult than improving feed or industrial varieties because requirements of shape, color, flavor, and vitamin content are much more exacting. Some releases have been made from the Louisiana Station but they are considered only as steps in the right direction. We want

high resistance to wilt and to soil rot, high carotene content, attractive shape and skin color, and high yield. We have some promising numbers that surpass Porto Rico in carotene content and yield, but we are not yet sure they are good enough in all other respects. We now have on hand parent materials that will give us the desired combinations of characters we need. Incidental to this breeding work a seedling from Australia was introduced that has proved excellent for canning. It has been named Australian Canner and released to the public.

### BEANS

I have already mentioned Florida Belle and Florida White Wax beans that were selected in Florida from lines produced at the Vegetable Breeding Laboratory. U. S. No. 5 Refugee has greatly outyielded many of the older varieties, proving its superior adaptability to the South. Although it has never become a dominant variety because of market preferences, it is one of the early illustrations of what can be done to improve adaptability to the soils and climate of Southern bean-growing districts. Logan is a new variety, developed at Charleston, that is in great demand because of its high quality, disease tolerance, and high yield. Many numbers, still unnamed, are being cooperatively tested to find just what the growers, shippers, consumers, and home gardeners want.

The lima bean is one vegetable of which the markets, canners, and freezers have never had enough. The old varieties are so unproductive or otherwise of such limited usefulness that the demand for good limas has never been satisfied. Home gardeners too have had their troubles in getting productive varieties of the

desired high quality. In the past few years the Department's release of Early Market, Fordhook 242, Peerless, and Triumph lima beans has helped greatly insofar as quality and yield under certain conditions are concerned. These varieties, however, are not resistant to mildew, a serious trouble in the Middle Atlantic States, or to nematodes, which are generally a problem to some extent throughout most of the South and Southwest. Members of our staff at Beltsville and at Charleston are working intimately with the specialists in the Division of Nematology and with plant breeders in numerous States to incorporate mildew and nematode resistance into high-quality limas. The California and Oklahoma stations are furnishing their nematode-resistant lines and doing very extensive testing work. Our men are doing most of the controlled crossing and growing of first generations as well as growing, testing, selecting hundreds of lines. Dozens of State men over the country are helping evaluate the breeding lines in comparison with existing varieties. One of the most interesting things about this far-flung cooperation is that it is entirely informal. Nobody is bound, on paper, to do anything; no agency makes any money available to any other. At least 50 men over the country are giving some portion of their time to this nicely coordinated work, because they see the advantages in so doing.

#### WATERMELONS

Your own State has long been a leader in developing wilt-resistant watermelons. One of the big tasks now before us is learning how to incorporate better shipping properties, high eating quality, disease resistance, and productivity all into each new variety produced. The

Regional Vegetable Breeding Laboratory has recently made some rather surprising findings about resistance to breakage of watermelons. We had thought that the main thing to breed for, to resist breakage, was hard rinds. A paper in press now that shows us that the edible part of the flesh may offer a great deal more resistance to breakage than does the rind. That does not mean, however, that a melon resistant to breakage must have a tough or undesirable edible part. This work helps explain why we still get too much breakage in melons having tough rinds. It appears that in selection for resistance to breakage in the past, the most important character may have been overlooked. The laboratory is preparing to release seed of a new variety this winter to seedsmen. It looks very good in Florida.

#### TOMATOES

Plant breeders now know how to put a very high degree of fusarium wilt resistance in the tomato. The discovery of virtual immunity in a wild form from Peru and its incorporation into Pan America about 10 years ago by our people at Beltsville has shown how to do it. There still remains, however, much work to be done on resistance to such leaf and stem diseases as alternaria, or early blight, gray leaf spot, and late blight. The Charleston laboratory has probably done more on this general problem than any other one group.

The magnitude of the ground work that has to be done is enormous even before an actual breeding job can be started: Developing dependable methods of testing for resistance, finding resistance in wild or foreign varieties that can be used as parents. It takes years of unspectacular, unpopular drudgery.

Some people may wonder why we have put out no more leaf-disease-resistant varieties than we have to date. Our main job is first to help bridge the gaps that have had us all stalled—commercial breeders and State workers as well as Federal.

The Charleston laboratory has just released the variety Southland which represents two important advances. Besides resistance to wilt, it has resistance to collar rot and some tolerance to one form of late blight. It was this partial resistance to late blight that brought this line into prominence 2 years ago. Southland is no miracle variety—it is a good step in the direction we are trying to go. It is an improvement, but we hope it will be superseded in a few years by far more resistant sorts.

#### POTATOES

The National Potato Breeding Project represents the joint activity of our own Potato Project together with about 35 State projects. Each agency does what it can and exchanges materials and information freely with all others. Our people concentrate on the job of obtaining and testing parent materials from all over the world, making numerous crosses of promising combinations under controlled conditions in the greenhouse at Beltsville where they can best be made, growing tens of thousands of seedlings, then distributing promising seedlings to all who can work with them.

As in the case of other crops mentioned, the Federal men devote major attention to the background work that is basic to the whole program, including studies of inheritance to specific diseases to which resistance is sought. The progress of this work is indicated by the fact that half of all the certified seed potatoes

now grown in the country consist of varieties that have come out of the National program. As things have worked out, more superior varieties have been produced that are suited to the Northern part of the country than to the Southern part. Because of the very nature of the potato and its growth requirements, that is what we would expect. We still do not have satisfactory early disease-resistant kinds. Although the partial blight resistance of Sebago is making it popular in Florida and Alabama, displacing Irish Cobbler and Bliss Triumph to a considerable extent, we need still better varieties for the South. At our Southern cooperative headquarters at Baton Rouge, La., and in all the States of the region work goes forward to meet that need.

#### SCLEROTINIA DISEASE

Some problems cut across crops and must be attacked on a wide front, not in terms of a single crop or even a single region. The sclerotinia disease is an unfortunately outstanding example. It has increased to disastrous proportions on beans and many other vegetables in recent years in southern Florida; it is serious on beans, 'squash, and members of the cabbage family in the Pacific Northwest; and even in some irrigated districts of the West it is increasing its damage to beans. Federal men in Florida, Oregon, and Washington are working with State men upon several possibilities of control: Spraying and dusting with all conceivable fungicides, both old and new; soil treatments; soil flooding; searching for disease resistance; studying the fungus that causes the trouble.

When a pathologist sets out to find a control for a plant disease, it helps a good deal if he can know what causes

the disease—not only the fungus, bacterium, or virus, but what set of conditions makes it possible for the disease agent to do damage at one time and place, and not in another. As we look back over the crop history and management of many of the fields now plagued with sclerotinia, we think we can see some of the reasons for trouble in some of the places at least.

To make a long story short, cropping systems and cultural practices are being followed, in most instances, that we should expect to lead to trouble sooner or later. Things are being done that create ideal conditions for the parasite, that so violently disturb the balance of natural conditions that trouble is inevitable. We grow the same susceptible plant continuously on the same patch of land time after time for years. We plant too thickly, and irrigate heavily in the effort to get the last possible pound of production, not realizing that by so doing we make conditions just right down among the plants for the disease to run riot. We neglect to supply organic matter in such a way that something like normal processes can be maintained in the soil.

Frankly, we don't know the answers to this sclerotinia problem yet, but I do think it is safe to say the trouble is primarily the result of unwise production practices—upsetting nature too far by over-intensification and over-specialization in susceptible crops. Some growers seem to expect the plant breeders to produce varieties that can be grown continuously, indefinitely, on the same ground without having to worry about anything—just fertilize, plant, and harvest. I don't believe that is a reasonable objective—it is expecting too much.

Regardless of what the scientist is able

to develop in the way of chemicals and varieties, we are going to have to learn more about what happens when crop plants, soils, and micro-organisms are in balance in nature. We are going to have to learn how to give natural forces a better chance, and be willing to let those forces operate for our own advantage. Meanwhile, we search for whatever relief we can get for this disease. Sooner or later, however, we must all get down to fundamentals on the whole problem of soil-borne diseases and learn how to avoid them by natural means. That may call for one of the most comprehensive, cooperative projects yet undertaken.

#### VEGETABLE PLANT GROWING

Another line of our work in the South is that relating to the growing of vegetable plants for shipment northward for transplanting. Most of our attention so far has been given to tomatoes because they constitute the greatest part of the industry and tomato plant growers have been the ones most seriously beset by trouble. The work has shown the way to improved planting, cultural, spraying, harvesting, and handling practices. Since investigations were started in southern Georgia the number of tomato plants harvested per acre has been approximately doubled. (Some improvement doubtless would have occurred if we had not been working on those problems.)

We have found no control, however, for incessant rain—losses of plants in such years will be high in spite of our efforts. The greatest gains have come through improved rates, uniformity, and timing of planting on better prepared land, and through better application of conventional disease control measures. Work with fungicides continues. Work is in progress now to improve soil manage-

ment, green manure and fertilizer practices to give a more steady, sturdy, plant growth; to furnish plant nutrients that will be available to the plant as needed but will not be leached out severely by excessive rain.

#### OTHER ACTIVITIES

Many lines of work besides those mentioned are in progress mainly at locations outside the South, but which will doubtless prove beneficial in the South. Seed investigations in the West and at Beltsville have a direct bearing upon the vitality and freedom from disease of the seed you plant.

At Beltsville rather extensive studies are being made to try to determine the possible hazards and also the safe limits of use of the various chlorinated hydrocarbons, such as DDT, and other new compounds now used as insecticides. Some crops, such as beans, vine crops, tomatoes, and some varieties of rye, are slightly to very sensitive to some of these compounds in the soil. Depression of growth is caused by a smaller amount on some soils than on others. And even varieties of a single crop differ in their sensitivity to these compounds. Although most of these compounds are

apparently very persistent in soil, we don't know how long their toxicity will last or how long it will take to accumulate harmful amounts in any particular soil. At the rate some growers are using these materials at present, some of us fear that harmful residues will be accumulated in their soils in a very few years. This is one of our urgent problems and I wish the States were doing more work on it. We need the answers now, but unfortunately a number of years will probably be required to get many of the answers.

Our division also conducts extensive studies on the methods of handling, packing, prepackaging, shipping, and storing of vegetables. Other divisions of our Bureau are working on specific problems of soils, fertilizers, irrigation, weeds, and disease surveys that are of importance to vegetable growers. The Bureau of Entomology and Plant Quarantine has a large amount of work in progress in the South on the control of insects that attack vegetables. The work in each of these several fields is a story in itself and can not be presented here. They are mentioned, however, to indicate the breadth of Federal work that is concerned with vegetable crops.

## EXTENSION WORK WITH VEGETABLES IN FLORIDA

H. G. CLAYTON

*Director Florida Agriculture Extension Service*  
Gainesville

The job of the Cooperative Extension Service in Agriculture and Home Economics is education. The primary objective is to serve rural people, however the benefits have extended to the people in

urban areas and to others. This is the division of the University which carries to the farms the application of scientific developments and of agricultural research which result in the use of more efficient methods that apply to crops, livestock, and forest production and to land improvement and water conservation. Through Home Demonstration work with farm women and through 4-H

Boys and Girls Club work and activities, Extension work has resulted in improving family diets, family living conditions, better health, and economic improvement. Through 4-H programs club members have developed skills and acquired useful information of value as farmers and homemakers of the future. Extension aids rural people to help themselves and to develop leadership and group action. What Extension has helped people do for themselves is where the greatest results are achieved.

When we single out a specific commodity and talk about Extension work with this commodity we need to cover some of the past and also plans for the future. Also when we single out a commodity there are other related items and in the case of vegetables these would involve cover crops, irrigation, drainage and crop rotations in addition to production, preparation for marketing, and marketing.

The County Extension worker is a general practitioner and cannot know all about everything in the agriculture of his county so he must know where the technical information can be secured in case of unusual situations. He must also keep informed about the research work being done so he can help to carry the results to growers in his county. He also assists the research workers in arranging field days when growers can come to see the progress being made and learn new methods and procedures.

In Florida with its varying soils and diverse conditions the vegetable growers problems are in many cases extremely localized. The Main Station, Branch Experimental Stations and laboratories are always at work on research problems and some of these institutions work solely on vegetable problems. These

are the chief sources of information used by Extension workers. The U. S. Department of Agriculture is also engaged in research work with vegetables both in production and in marketing. Various agencies of the department have a part in the over-all vegetable picture. There are the market news and crop reporting services, the frost warning service, the outlook and commodity reports. All of these services are used as well as those of the Farm Credit Administration which finances many producers in Florida. Varieties, fertilizers, insecticides, and fungicides are all items of concern to the County Agent and to the vegetable grower.

In the Extension Service we have a number of specialists who act as a subject matter clearing center and serve as contact people with the research workers. They are two way conveyors of information and bring to the research people their field observations and carry to the field things they learn from research workers. Until recently we did not have a vegetable specialist on the staff. Now arrangements have been made so Dr. Jamison is half time research and half time Extension worker. We feel very fortunate in this arrangement and think it is good in many instances to have one person head up State-wide the various lines of work relating to a commodity. This seems to be very desirable with vegetables where the research work is widely scattered. Not all people could handle a situation of this kind but we believe Dr. Jamison can and that all of us—the growers and research and Extension workers—will also benefit by this arrangement which will get everything working along the same beam.

In the case of the new organic insecticides and fungicides used so much on

vegetables, a team of workers representing the Industry, the Experiment Station, and the Extension Service is now working up some material that is out ahead of anything we know about, in order to have a basis for keeping up with the rapid changes and new developments in these materials.

During the war county agents were engaged in a number of wartime programs relating to such things as rationing, agricultural building restrictions, farm labor, gasoline rationing, draft deferment, and similar programs. These programs consumed a lot of time from the regular work and now we are glad to get back full time to the regular program of work. In order to strengthen and enlarge the vegetable program we have recently established a county agents' vegetable advisory committee. The five agents on this committee represent all phases of the industry. This committee will help to develop and improve the Extension vegetable program to as fully as possible to cover the field.

During the past year county agents devoted 1,473 days to work with vegetables and potatoes and some vegetable work was done in 55 counties. 1,798 farmers were assisted in obtaining improved varieties or strains of seed. 4,142 farmers were assisted with the use of fertilizers, 4,643 with controlling diseases and 5,572 with the control of injurious insects. Our records show that county agents devote approximately the same amount of time to vegetables as they do to citrus. Due to the very nature of the many vegetable problems many of the calls on the agents require personal visits to the fields, as they cannot be handled satisfactorily in any other manner and in some cases necessitate contact and may be a visit from a research worker.

We have a research and marketing administration vegetable project approved and we plan to get this underway in the near future. A good deal of the material for this project has already been secured and we hope to get it underway soon.

To some of you it might be of interest to present some facts about Extension work with home gardens and with Home Demonstration and 4-H Club garden projects.

There are a large number of Florida boys and girls enrolled in 4-H Club work and they carry on a wide variety of projects and demonstrations. Gardening has always been a popular project as it is well adapted for both boys and girls and does not require so large a plot of ground as do such projects as corn, cotton, and peanuts.

In 1947, club girls canned 123,657 quarts of vegetables and in addition they also brined a considerable quantity of vegetables and froze 2,162 pounds. They gave 2,595 quarts of food, most of which was vegetables, for famine relief. In six counties 4-H Club girls and Home Demonstration clubwomen assisted 11 communities with school gardens. In 31 counties assistance was given in 195 communities with the school lunch program where 36,476 children were fed. In these activities involving health through nutrition vegetables played an important part.

In 1947, girls completed 2,145 garden projects and 3 market garden projects while the boys completed 1,246 garden projects on a total of 1,220 acres and 127 market garden projects were grown on 174 acres.

The negro 4-H Club boys completed 912 garden and truck crop projects while the girls completed 1,410 projects. The negro agents work with the club mem-

bers and also work with adults in food and nutrition, and in this whole field they reported 3,764 gardens were grown and that 2,563 families canned 280,159 quarts of vegetables, fruits, and meat.

In a very brief way this indicates that work with vegetables is important in 4-H Club work. In nutrition and health

work our Home Demonstration specialists and Home Agents working with the mothers and homemakers in County Home Demonstration Councils have done a fairly comprehensive job on better health through better nutrition, and in this the use of vegetables, their nutritive value, and how to prepare them have been stressed.

## THE FLORIDA SEED LAW: ITS GOOD FEATURES AND IMPROVEMENTS NEEDED

PHIL S. TAYLOR

*State Department of Agriculture*  
Tallahassee

I believe it was the great English jurist Blackstone who said that the object of law was to discourage that which was wrong and to encourage and protect that which was right. This, we believe, should be particularly true of regulatory laws relating to agriculture. There is no good reason for any of these laws other than the protection which they afford to a good cause and the discouragement and opposition they offer to men of low ethics.

### FLORIDA'S FIRST SEED LAW

Florida enacted its first seed law in 1941. We were next to the last State in the Union to pass such a measure. As originally passed the measure was, like most new statutes, inadequate and only partial in its protective features. Amendments have been made which in some respects strengthen the law. Today I am attempting to point out the good features of the present measure and some improvements that might well be made.

### FEATURES OF LAW

Turning to the better parts of the measure, we may say that its purpose is set forth in the caption, as follows: "An Act to regulate the sale, offering for sale, and transportation of agricultural and vegetable seeds and providing for inspection and testing thereof; to prevent misrepresentation and fraud in the advertising and sale thereof \*\*\*." The first step in compliance with the law by a seedsman is that he register with the Commissioner of Agriculture, giving the number and location of each place of business and pay a registration fee according to the volume of his business. These fees begin at \$1 for business not exceeding \$1,000 and are graduated upward to the highest fee of \$500 on receipts of over \$500,000. The total of registered seed dealers for the year 1947-48 reached 748. You may be interested to know that receipts from registration fees for that year aggregated \$11,845. While this is a considerable amount of money, we must point out that it does not equal the total expenses incurred in the enforcement of the law.



### INFORMATION REQUIRED ON TAGS

Our law, like most seed laws, requires certain definite statements to appear on the tag for the information of the buyer. Chief of these requirements are the name of the seed and its variety; its net weight; place where grown, if known; percentage by weight of all weed seeds; percentage of germination; month and year when seed were tested; name and address of the person who labeled the seed or who is selling it.

### PROHIBITIONS

Under Florida law it is unlawful to sell, offer for sale, expose for sale, transport or distribute seed within this State not labeled to show the information stated above. In addition, it violates the law to carry a false or misleading advertisement pertaining to seeds; to sell seed carrying weed seeds in excess of the limits; to detach, destroy, or use a second time the tag required by the law; to alter or substitute seed so that they may defeat the purpose of the act; to hinder or obstruct in any way any authorized person in the performance of his duties under the act; to fail to comply with Stop Sale order or Seizure order; to sell or offer seed for sale without having registered as a dealer unless specifically exempted.

### EXEMPTIONS

The Seed Act of Florida does *not* apply:

1. To a common carrier in respect to seed transported or delivered for transportation in the course of its business as a carrier unless the carrier is engaged in processing or selling seed.
2. To seed or grain not intended for sowing or planting purposes.
3. To seed being held by, consigned

to, or transported to seed-cleaning establishments for cleaning or processing.

4. Seed grown, sold and delivered by the producer on his own premises, where such operation is merely incidental to his business of farming, is exempted from the Seed Act unless such seed be advertised for sale or delivered by common carrier. This exemption to producers, however, applies only to the first 1,000 pounds of agricultural seed sold during any 1 year.

5. If seed are sold from a properly labeled container in the presence of the purchaser the seed so sold are not required to be tagged unless the purchaser so requests.

### AUTHORITY OF THE COMMISSIONER

The Commissioner of Agriculture may employ sufficient assistants as shall be necessary to enforce the Act; may sample, inspect, analyze, and test seeds; adopt rules and regulations as to sampling, inspection, tests, and examination of seeds; fix the tolerances applicable thereto; enter any place where seeds are sold to take samples and make investigations, and place Stop Sale Notices on illegal seed.

### SEED TESTING

Samples of seed under the Florida law may be sent in by dealers or farmers for testing in the State Seed Laboratory. Fees to cover the costs of such testing may be fixed by the Commissioner. The laboratory shall make necessary tests for determining the germination, purity, and such other factors regarding seed as may be prescribed by the Commissioner or found necessary.

### PACKET SEED

Perhaps more individual purchases of packet seed are made in the State of

Florida than of any other type of seed. Our law defines packet seed as being seed put up in packets containing less than 8 ounces. Special inspection fee stamps are required to be displayed on packet seed containers, the fee being at the rate of 50c for each 110 dozen, or fractional part, of such packages in the display box.

#### SEED LABORATORY

The Seed Laboratory operated by the Department of Agriculture is the fact-finding agency respecting the real quality of seeds. Here trained technicians using precision instruments, microscopes, delicate scales, and germinators operated at given temperatures, run tests on thousands of samples sent in by seedsmen and farmers and collected by our inspectors. During the 2 years beginning July 1, 1946 and ending June 30, 1948, a grand total of about 10,000 samples passed through our laboratory and were tested. Lots of seed found unfit for planting purposes were destroyed or used for animal feed, and much seed found below standard was caused to be relabeled and sold under a label carrying the words "Below Standard." Many other lots were found untagged or incorrectly tagged, and the owners were required to conform to the tagging requirements.

#### BENEFITS OF LAW

It is gratifying to state that most Florida seedsmen appreciate the value of the Florida Seed Law in determining the true quality of seed and in requiring at all times proper labeling and testing of their stocks. We believe that the law has appreciably reduced the proportion of bad seed and by the same token considerably enhanced the quality planted

in this State. We believe growers are becoming more "tag minded" and are qualified better than ever to evaluate the real quality of the seed through a careful study of the declarations made upon the tag. We believe that more and more seedsmen in Florida are selling less and less bad seed and that more and more growers in Florida are planting more and more good seed.

#### IMPROVEMENTS NEEDED

*Vegetable Seed.* It is of particular interest to the important vegetable growing section of Florida that the law be materially strengthened in respect to vegetable seed. Under the present statute a great deal of substandard vegetable seed may be sold provided it is marked "Below Standard," on condition that seed so marked shall not fall more than 20 percent below standard fixed for such seed. This provision of the law, in my judgment, is too lax and in effect permits the sale and use of entirely too much seed of doubtful quality.

*Registration Fees.* We believe that the registration fees prescribed by the present statute should be amended with particular reference to the fees in Bracket A. Here we must permit a dealer whose sales do not exceed \$1,000 per year to operate his seed business on a fee of \$1 per annum; but should another dealer sell \$1,001 worth of seed in any one year, his registration fee automatically climbs to \$25. We believe this gap should be shortened by raising the registration fee in Bracket A from \$1 per year to at least \$10.

*Date of Test.* Section 4 should be amended to clarify the requirements as to date of test. Our Department feels that the date of test should be fixed uni-

formly to run 5 months and thus come into agreement with the Federal Seed Act.

*Disclaimer Clauses.* For 3 successive years the Association of Commissioners of Agriculture of the United States, in their annual gatherings, have expressed by resolution opposition to the use of disclaimer or nonwarranty clauses on official seed tags. This year at their meeting in Portland, Oregon, they passed a stronger resolution, which reads as follows:

*"Resolution No. 13: Disclaimer or Nonwarranty Clauses.*

"Whereas, The primary purpose of regulatory laws relating to agriculture is to foster and promote agriculture and to protect the buying public, and

"Whereas, This Association favors the enactment and strict enforcement of measures which afford full information and protection to the buyer, whether that buyer be farmer or otherwise,

Now, Therefore, Be It Resolved, By the National Association of Commissioners, Secretaries and Directors of Agriculture that we hereby record our opposition to the use of nonwarranty or disclaimer clauses which are designed or worded to evade the responsibility of seedsmen and to mislead farmers as to the protection which seed laws afford them. In all cases where State laws require a statement of the variety, germination, purity or other qualities of seed to appear on seed tags, we favor and recommend that appropriate legislation or regulations be provided to prohibit the use of disclaimer or nonwarranty clauses upon such tags, letterheads, advertising, or other forms of publicity."

This expression on the part of the high-

est ranking enforcement officials having to do with agricultural laws should convince all of us that disclaimer clauses have been used to mislead farmers into the belief that seedsmen cannot under any circumstances be held responsible for anything more than the purchase price of the seed, regardless of how bad the seed were or how great a loss may have been sustained by the grower through their use.

#### SPECIAL AND OFFICIAL SAMPLES

Under our Florida Seed Law, growers and seedsmen may send in what is designated as Special Samples for testing in the State Seed Laboratory. During the past 2 years 7,440 of these Special Samples have come into our laboratory for testing at nominal cost, much below the actual expense of the operation. In contrast to this, we have had 2,166 Official Samples. Now to my point: Please understand that the Special Samples, even though they may reveal the presence of bad seed in the hands of seedsmen, are not usable by us as the basis for the issuance of Stop Sales because the law has been construed to exempt such seed from seizures. That means that even though our laboratory tests determine beyond a doubt that a given lot of seed is so low in germination or so mixed with noxious weed seed as to render it totally unfit for sale for planting purposes, we may not legally impose a Stop Sale order on such seed unless and until we actually find it to be on sale to other dealers or to planters. The law should be clarified so that its teeth might bite unethical seedsmen who may have quantities of very low quality seed in their possession which, under present conditions, cannot be reached by a restraining hand of the law.

### NOTICES OF SHIPMENT

The enforcement of the Florida Seed Act would be made tremendously more effective if the law contained a requirement that Notices of Shipment of wholesale lots should be required to be given to the Commissioner of Agriculture at the time of the shipment. This requirement has been effective for years in the Florida Fertilizer Law and has enabled our field men to locate, inspect, and sample fertilizer before it has been put into the ground. If the same rule were made to apply to wholesale deliveries of seed within the State of Florida, it would expedite proper enforcement of our State Seed Law.

### BLENDING

We come now to a statement as to a practice commonly referred to as blending. Under this practice seed falling far below the standards fixed may have been mixed with seed of the same variety which are not high in germination or other factors and the blended lot may thus be brought above the standard and sold. This system beyond a doubt permits many lots of seed which may fall as low as 25 percent in germination to be

skillfully commingled with a lot of high germinating percentage and sold at the price which the better seed alone would have commanded. One of the deplorable possibilities in such a situation lies in the fact, little known or discussed, that in a given lot of seed which may test only 25 percent germination you not only have three-quarters of the seed which will not sprout at all but you also have a great proportion of the 25 percent which will sprout to be so low in vitality that they cannot be expected to grow into normal healthy and productive plants.

Furthermore, it is well to remember that blending of seed increases the danger of spreading seed-borne diseases. The mixing of a lot of diseased seed with seed free from disease will certainly result in infecting the entire lot.

The practice of blending has been discouraged for years by many law enforcement agents. A great many ethical seedsmen have already discontinued blending entirely or have greatly restricted it. We believe that such action should be taken in Florida through appropriate amendment of our Florida Seed Law, under which blending may not be done with impunity.

## WHERE DOES THE MONEY COME FROM?

JOHN A. DULANY, MANAGER

*Lake Okeechobee Farmers' Cooperative*  
Pahokee

We, in the business of converting the sweat of the brow into the coin of the realm, must keep constantly on the alert to anticipate trends of demand, and see

that our offerings conform as near as possible to those demands. When I say demand, I mean the consumer's demand, for he is the only person who puts real money into the transaction. The grower intends at least to invest for a profit, the buyer intends to invest for a profit, so does each handler, then it follows that we must meet the requirements of the

consumer, and in so doing, each step back to and including the grower, will have performed a satisfactory business transaction.

The buyer resistance to on-the-farm grade and pack is becoming very strong, due to a wide variation in the quality offered by individual growers. It appears some centralized grading and packing plants should be utilized. The fact that this is being done in some areas rather extensively, and as demand can be met with proper grade and pack, those farmers not availing themselves of these facilities, will surely sell their produce at a very low comparative figure.

Few individual growers have volume enough to justify the investment required for modern grading and packing, and without substantial volume, labor would be difficult to employ. Farmers cooperatives seem to be the best answer to this problem, where grading, packing, and selling can be done cooperatively in large volume.

Grading and packing should be done for the grower who retains ownership after packing, thereby benefiting from a proper grade and pack.

The grower and country shipper must be concerned with the performance of his commodity in competition with other food items. Recently, the National League of Fresh Fruit and Vegetable Distributors launched a Nation-wide publicity campaign, using newspapers, magazines, and radio, in connection with distribution education classes in handling fresh fruits and vegetables.

The League's Washington office, prepared special releases for each medium—dailies, weeklies, magazines, and radio, covering every trading area in the United States.

The radio script and "fact sheet," set-

ting forth all phases of this educational program, was placed with 525 radio food editors throughout the country. A story stressing the consumer benefit to be derived from the program and designed to improve retailer consumer relations was beamed to 338 metropolitan daily food editors. The response was such that the country was virtually blanketed by this release. A story emphasizing the grower and shipper "stake" in streamlining and modernizing of retailing perishables was placed with 388 smaller newspapers in a<sup>1</sup> producing sections of the United States. A magazine story was directly beamed at United States retailers through the medium of 67 especially screened retail food store trade publications. Another release was prepared for a large group of radio farm editors, explaining the distributive education program; how it works and how it will benefit the farmer.

Baltimore recently launched its distribution education course in handling and merchandising fresh fruits and vegetables, with 29 registrants making up a combination retailer-wholesaler class. The program has not only the enthusiastic support of the enrollees themselves, but the endorsement of the Independent Retail Grocers and Meat Dealers Association, the Baltimore Department of Education, and the University of Maryland Extension Service.

As in the case in every city where classes are being conducted, the course is based on the "instructor's manual," a guide to better handling and more efficient merchandising of fresh fruits and vegetables, prepared by the National League.

From the foregoing, we can see the trend is toward orderly and better distribution. We, at the grower level, will

need to grade and pack in a more efficient manner to tie into this Nation-wide program.

The extension service of the University of Florida might be able to watch the trend and supply material for adult education in fitting the country shipper into the wholesale-retail program.

Farmers as a group, may expect somewhat lower income in the next few years, because costs will be higher in relation to prices received. If a sharp recession occurs, the drop in net farm incomes will be severe. Prices of farm products are not likely to decline appreciably during this year, but present high levels are not likely to continue indefinitely. While the general price level and business activity may maintain their present altitude for some months; a readjustment is probable within the next year or two.

Efficiency in farm production is up to the farmer, whereas efficiency in marketing of farm products and purchasing of farm requisites is up to farm cooperatives and other corporations engaged in these activities. When prices decline, marketing costs will be more important, because marketing margins will lag and remain relatively high. Hence, criticism of marketing agencies and pressure for economy in marketing will increase. While marketing is always important, now is a good time to emphasize studies of marketing methods to find ways of doing a better job at a lower cost.

The days when inefficient organizations could get by are coming to a close, and keen competition is sure to follow. It is important to emphasize quality, as well as efficiency, for premiums for bet-

ter products will justify the higher cost that may be involved.

The most important economic problem of agriculture of the United States is the reduction of the violence of economic fluctuation, the reasonable stabilization of favorable levels of prices, production, and employment.

Some fluctuation is probably inevitable as long as human beings become alternately over optimistic, and over pessimistic. These minor movements, or business cycles, are like the waves of the ocean and are not a cause of major difficulties. It is the great depressions, the tidal waves, which raise havoc with modern economic society.

In order to reduce the violence of depressions, it will be necessary to discourage over optimism during booms. The importance of this problem justifies the use of the best brains and ingenuity, and the support of agriculture and business.

Reducing the violence of economic fluctuations is not a panacea for all economic ills. It would not solve all economic problems of the Nation but it would reduce them to manageable proportions.

The Nation has learned that it cannot have a really prosperous agriculture, unless the rest of the economy is prosperous. It has learned that agricultural income, and national income, rise and fall together, and that each affects the other. It should be learned also, that we cannot stabilize our economy piecemeal, one crop, or one industry at a time.

Remember our customer, the consumer, is tied into all of these problems. Give him good food value, with a maximum of nourishment and a minimum of waste.

# SOME RESULTS OF PREPACKAGING VEGETABLES IN 1948

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*Florida Agricultural Experiment Station*  
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AND

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During the first half of 1948 extensive investigations of commercially prepackaged broccoli, cauliflower, and sweet corn were made at Ruskin, Florida. Approximately 80,000 cartons (each with 12 packages) of the three vegetables were grown, packaged and marketed by a Ruskin grower. The Department of Horticulture of the Florida Agricultural Experiment Station and the Bureau of Plant Industry, Soils, and Agricultural Engineering of the U. S. Department of Agriculture conducted these tests jointly under the Research and Marketing Act in cooperation with the Florida Prepackaging Council. Detailed physiological and economic studies of prepackaging at the shipping point were made to determine the feasibility of this method compared to packaging at the retail level.

The physiologists were confronted with the problem of maintaining the original freshness, taste, color, and composition from the time of harvest in the field until the packages reached the consumer. Although little difficulty was experienced in preventing weight loss or

wilting in the film wrapped packages, the conditions were ideal for the growth of microorganisms. Attempts were made to maintain freshness and control decay by means of precooling, low temperature storage, and antiseptic treatments.

The broccoli and cauliflower were graded, trimmed, washed, precooled, and packed into open-top cardboard trays while moving on a conveyor belt through the packing shed. Each tray, containing 10 ounces of broccoli or cauliflower, was then machine wrapped and heat sealed in perforated cellophane which prevented the excess accumulation of respiratory gases. The sweet corn was mechanically husked, trimmed, washed, and precooled. Trays containing three 5-inch ears lengthwise or five 3-inch ears crosswise were then wrapped and sealed in cellophane. Ventilated cardboard cartons were used for storing and transporting the packages to the Florida and Northern markets.

Before packaging the vegetables were precooled on a mesh belt while passing through a 30-foot tunnel under a continuous shower of mechanically refrigerated water. Series of temperature readings<sup>1</sup> were taken of broccoli and sweet corn starting with the field temperature and following through the decrease during hydro-cooling and the increase during packaging. These temperatures are shown in Table I with the corresponding water temperature and time in the hydro-cooler. The cooling cycle had to be shortened from 13 to 9 minutes in June to handle the increase

<sup>1</sup> All temperatures are reported in degrees F.

TABLE I  
THE INFLUENCE OF HYDRO-COOLING AND PACKAGING ON THE TEMPERATURE OF  
BROCCOLI AND SWEET CORN HARVESTED AT DIFFERENT DATES

Date	Time (min)	Water Temp.	Hydro-cooling			Packaging		Degrees Below Field Temp. After Packaging
			Vegetable	Temp.	Decrease	Vegetable	Temp.	
			Before	After		Before	After	
Broccoli								
Jan. 21	13	36	69	41	28	55	58	11
Feb. 19	13	—	79	48	31	57	58	21
Sweet Corn								
April 6	13	46	85	58	27	61	62	23
April 7	13	42.5	85	52	33	59	61	24
May 12	13	42.5	88	59	29	59	59	29
June 10								
8.15 AM	9	40	85	50	35	54	56	29
4:30 PM	9	41	86	53	33	—	—	—

in volume of corn. The temperatures were taken in the cob of the corn with fruit thermometers and inside the broccoli stems with thermocouples. The temperatures shown in the table are averages of at least 10 readings.

Hydro-cooling reduced the temperature of both vegetables approximately 30°. The field temperature of the broccoli varied from 69° on Jan. 21 to 79° on Feb. 19 and the reduction to 41° and 48° was nearly adequate. However, during the next 7 minutes while the broccoli was being drained and packaged the temperature rose to 58°. This rapid increase partly nullified the precooling effect and made further cooling necessary in the cold storage rooms.

The corn ranged from 50° to 59° after hydro-cooling and from 56° to 62° after packaging. This precooling was very inadequate for the corn. The water temperature in the hydro-cooler varied with the volume and temperature of the corn being cooled. Attempts were made to keep the water temperature near 32°, but difficulty was encountered because of ice formation on the coils in the bot-

tom of the hydro-cooler. Experimental lots of corn held in the hydro-cooler, with an average water temperature of 37°, were reduced from 85° to 46° in 20 minutes and to 41° in 30 minutes.

Each cold storage room was refrigerated by three blast coolers, but there was little air movement among the cartons when large numbers were placed in solid blocks. The temperature changes in the cartons were measured with a twelve unit thermocouple cable. In a typical stack 8 cartons high, a pair of thermocouples (one in the center and one at the side) was placed in each of the top, middle, and bottom cartons. The decrease in temperature of prepackaged broccoli was compared with unpackaged broccoli in open wire baskets in the cold storage room. The resulting temperatures, shown in Figure I, are the averages of side and center positions in the cartons or wire baskets. When the thermocouples were placed in the two lots, the temperature in the cartons was 56°, while the unpackaged broccoli was 42°. The packaged lot had increased 14° between the hydro-cooler and the cold



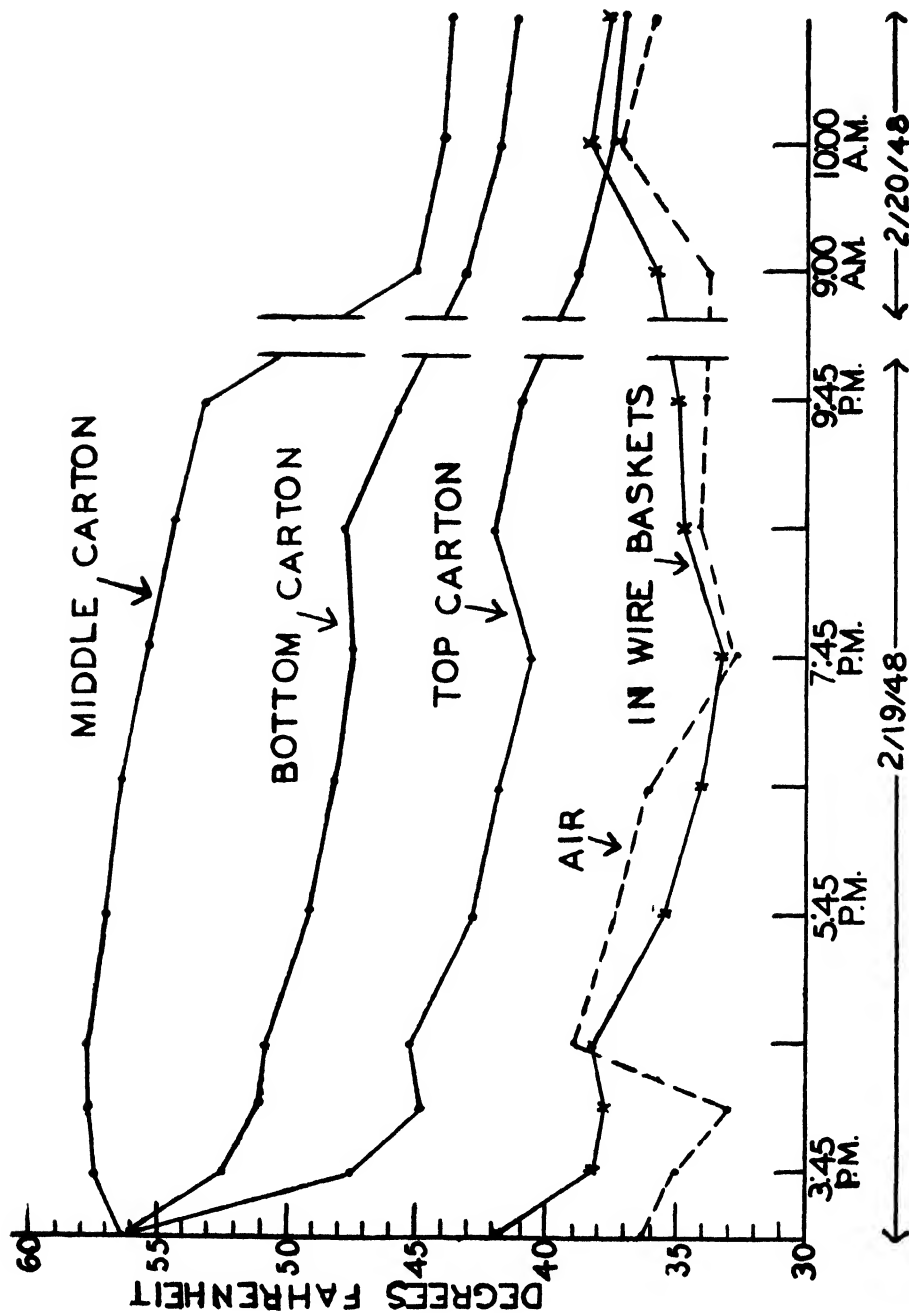


FIGURE 1. The Cooling Rate of Broccoli Held in Cartons and in Wire Baskets in the Cold Storage Room.

storage. The temperature in the middle carton continued to rise slowly during the first hour in storage, and remained the warmest position with temperatures of 55° after 5 hours and 44° after 19 hours. The coldest position was in the top carton. It received the most air circulation and reached the air temperature (37°) after 17 hours, as contrasted to 1 hour and 30 minutes required for the unpackaged broccoli to reach the air temperature.

Cartons of prepackaged broccoli were held in 35°, 45°, and 70° storage rooms to determine the changes in quality at the different temperatures. Broccoli held at 35° was fresh and green after 7 days and after 13 days was only slightly discolored on the cut surfaces. At 45° a small amount of soft rot and discoloration was found after the second day. Lots that were packaged and stored at 45° without hydro-cooling were slightly more wilted, discolored, and poorer in flavor than similar packages of broccoli which were hydro-cooled. After 2 days at 70°, both precooled and noncooled lots were unsalable because of decay.

The lowest sweet corn temperature obtainable from the hydro-cooler during a normal day's operation was about 50°, which was too high for shipping to the Northern markets. It was necessary to finish the cooling in the cold storage rooms. Thermocouples were placed in six experimental lots of corn on May 24 to determine the rate of cooling of packaged and unpackaged, and husked and unhusked corn. Figure II shows the temperature of the regular prepackaged corn (A) had reached a low of 44° after 18 hours in the cold room with the air temperature fluctuating from 33° to 40°. Corn prepackaged (H) at the same time and allowed to remain in the packing

shed (air temperatures 78° to 86°) had risen to 81° by 1:30 PM the next day (23 hours).

Two lots of husked corn, one hydro-cooled (E) and one uncooled (D) were placed in the cold room unpackaged in wire baskets. After 3 hours the hydro-cooled lot had dropped to 34° and the air cooled lot to 37°. At this time lots D and E were prepackaged and, after 18 hours, the temperatures were 4° and 5° lower than the regular pack with the additional advantage of more rapid cooling. Lots F and G were placed in wire baskets unhusked. Lot F was placed in the cold room and the temperature dropped slowly to 38° in 18 hours. Lot G was left in the packing shed, and the temperature fluctuated with that of the air.

Prepackaged sweet corn stored for 10 to 15 days at 35° was still in a marketable condition, but there was some loss of the original sweet flavor and some packages had a slight fermented odor upon opening. A similar decrease in quality was noticeable after 5 days at 45° storage.

Spoilage organisms were accumulated in varying numbers by the vegetables during the growing period, the harvesting in the field, and the handling operations in the packaging shed. If a method could be found for killing the microorganisms without injury to the vegetable or the person eating it, the storage life would be increased considerably. Several experiments were conducted with solutions of sodium hypochlorite and gaseous chlorine to determine the antiseptic properties of these two chlorine sources at various concentrations. Commercial hypochlorite bleaching solution with 5.25 percent chlorine was used in the first test. Broc-

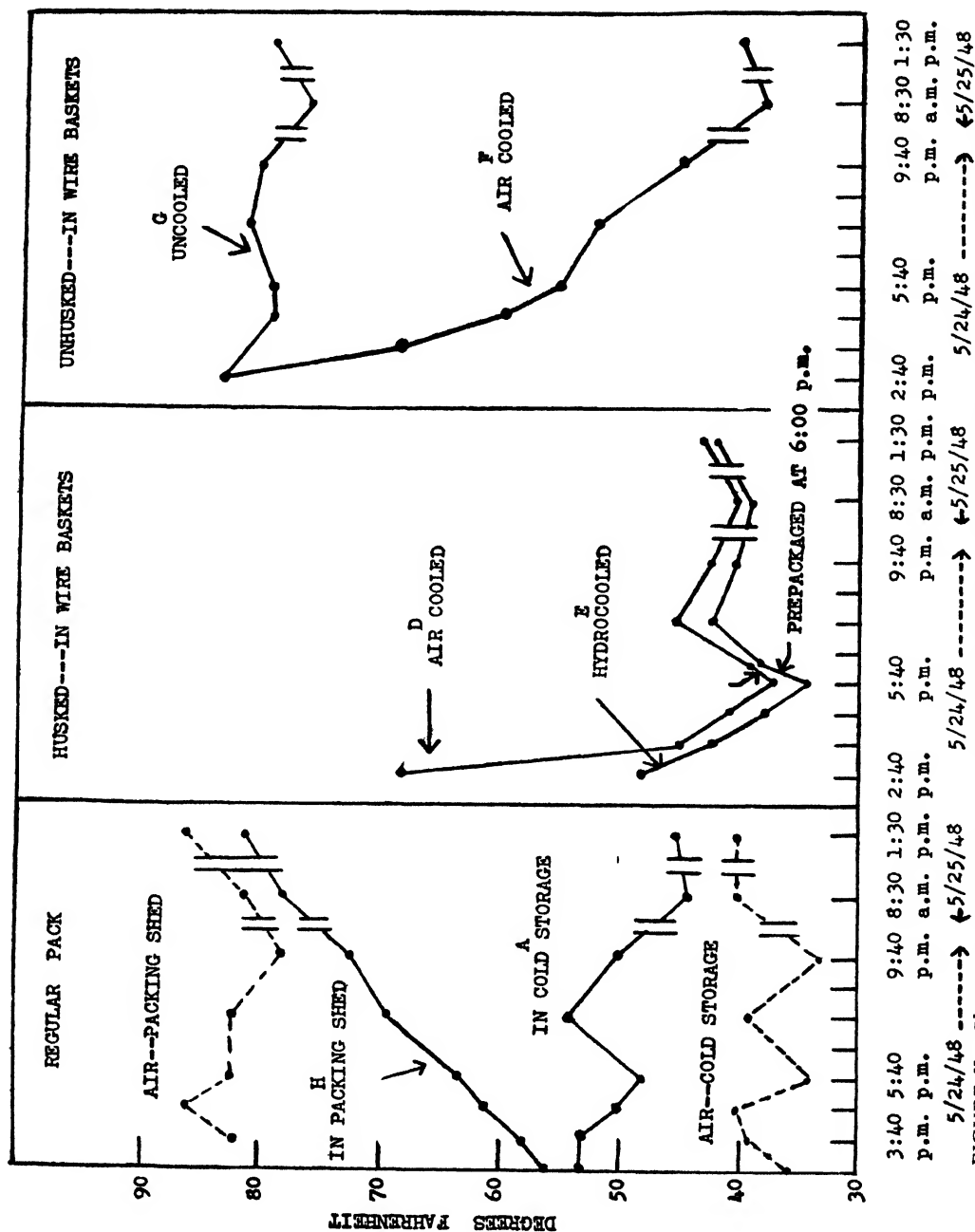


FIGURE II. Changes in Temperature of Husked and Unhusked Sweet Corn Held in Cartons and in Wire Baskets.

coli in wire baskets was immersed for 13 minutes (time of hydro-cooler cycle) in water containing 5 to 1000 ppm of chlorine. The broccoli was then packaged in the regular manner. At 35° all treatments, including the check dipped in water, were in good condition after 12 days. However, after 2 days at 70° there was considerable soft rot present in the low chlorine treated packages and the check. The treatments above 100 ppm showed no decay, but the high concentrations above 500 ppm produced considerable bleaching and browning of the broccoli leaves and dehydration of the cut stems.

In the second test higher concentrations of hypochlorite solution (0.5 to 10 percent) were used in treating samples of cauliflower with no noticeable chlorine odor or taste remaining when the samples were examined after 1 day at 70° and 8 days at 35°. As shown in Table II, the higher concentrations were effective in controlling decay and partially effective in controlling the darkening of cut surfaces during 2 days storage at 70°.

In a third test, four concentrations of gaseous chlorine were compared with four concentrations of hypochlorite as

antiseptic dips for cauliflower. Since the free or residual chlorine in water is reduced by organic matter and other impurities, titrations were made before and after dipping to measure the reduction of chlorine by the 15-pound lots of cauliflower. The results, as shown in Table III, indicate that in order to maintain the original chlorine concentration, additions would have to be made according to the amount of produce being treated. Table III also includes the pH determinations which indicated acid solutions from the gaseous chlorinated water and slightly alkaline solutions from the hypochlorite. The source of the chlorine made no difference in the rate of decay of the cauliflower in this test.

At 70° all the treatments were in good condition after 1 day, and all were inedible after 3 days due to physiological breakdown and decay. Treatment A (no chlorine) was in worse condition than all others. After 15 days at 35° the cauliflower in treatments, A, B, C, D, and F was in good salable condition, but treatments, E, G, H, and I had some browning and dehydration of the curd due to high chlorine injury. The greater amount of injury, from chlorine gas, may

TABLE II  
EFFECT OF HYPOCHLORITE DIP ON DECAY AND DISCOLORATION OF PACKAGED CAULIFLOWER  
AFTER 2 DAYS AT 70°

% Hypo-Chlorite Solution	Chlorine ppm <sup>1</sup> %	% Decay	% Discoloration
0	0	100	100
0.5	262	54	100
1	525	37	98
2.5	1312	33	92
5	2625	16	57
10	5250	0	37

<sup>1</sup> Calculated from hypochlorite solution with 5.25 % chlorine.

TABLE III  
RESIDUAL CHLORINE AND pH BEFORE AND AFTER DIPPING 15 POUNDS OF CAULIFLOWER IN  
5 GALS. OF CHLORINATED WATER FOR 13 MINUTES

Treat- ment	Chlorine Source	ppm Chlorine		pH	
		Dipping		Dipping	
		Before	After	Before	After
A	Check	0	0	6.6	7.0
B	Hypo-Chlorite	175	48	7.5	7.0
C	Hypo-Chlorite	358	184	7.85	7.4
D	Hypo-Chlorite	466	234	7.85	7.35
E	Hypo-Chlorite	600	430	7.9	7.6
F	Chlorine Gas	184	146	4.6	4.4
G	Chlorine Gas	490	330	3.9	3.9
H	Chlorine Gas	530	400	3.9	3.8
I	Chlorine Gas	630	560	3.65	3.65

have resulted from the higher residuals present throughout the dipping period in treatments G and H as compared to C and D.

When it was found that the experimental chlorine dips were somewhat effective in prolonging the storage life of packaged vegetables, chlorine was added to the water in the hydro-cooler. Samples of the unchlorinated hydro-cooler water poured with agar plates revealed the presence of a large population of bacteria, yeasts, and molds. In the regular operation, the water in the hydro-cooler was recirculated during a day's operation, and microorganisms were continually washed from the vegetables into the water. Concentrations of 1 to 3 ppm of residual chlorine when continuously maintained in city water supplies have been found to be lethal to most bacteria and molds. In this case higher concentrations were needed to kill the organisms in a short time and thus prevent wide distribution.

During the sweet corn prepackaging season the residual chlorine in the pre-cooler was maintained at levels of 20 to

100 ppm on different days. Agar plates were poured to determine the micro-organism count in the water at the end of the day's operation. Both chlorine gas and hypochlorite solution produced fairly effective control when maintained between 20 and 100 ppm. Concentrations above 100 ppm tended to corrode the equipment. Agar cultures made from the ears of corn after they were pre-cooled in chlorinated water revealed the presence of some yeasts, bacteria, and molds. The corn was not sterilized even though the organisms in the water were mostly killed.

In conclusion, the results of the pre-packaging studies at Ruskin emphasized the need for rapid precooling and a method of holding the vegetable temperature between 32° and 40° until marketed. Antiseptic treatments were of some value in controlling decay at higher temperatures, but with the low temperatures absolutely necessary to preserve the flavor, texture, color, and composition of fresh vegetables, decay seldom occurred during the time required for shipment and retail sale.

# AMARANTHUS GANGETICUS LINN, A NEW TROPICAL SPINACH

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*Amaranthus gangeticus*, Linn. a prolific and highly nutritious tropical spinach, has recently been introduced into Florida, and preliminary experiments on a small field near the University of Miami indicate that this tropical vegetable is entirely at home in its new environment. On good soils the plants

can be cut as a vegetable within 30 days after sowing.

This tropical spinach, under the name of *Amaranthus gangeticus*, Linn. is described by Burkill in his *Dictionary of the Economic Products of the Malay Peninsula*, p. 126, and by Herklots in his new book about vegetable cultivation in Hongkong, p. 94. Heyne in *The Nut-plants of the Netherlands East Indies*, p. 606, and Ochse in *Vegetables of the Dutch East Indies*, p. 25, have described



the same plant under the name of *Amaranthus tricolor*.

The cultivated forms of *Amaranthus gangeticus*, Linn, are of Chinese origin. From China they spread all over the tropics. The tropical spinach is now grown as a table vegetable throughout a large part of China, Malaysia, Indonesia, Indo-China, and the Philippine Islands. There are many varieties with colored or green leaves of different sizes. Red-leaved plants, usually eaten when very young, seldom come on the market.

Research workers in Java have shown that the leaves contain about 2% protein, 0.2% fat, 0.010  $\text{Fe}_2\text{O}_3$ , 0.22 $\text{CaO}$ , 0.07 $\text{MgO}$ , 0.50  $\text{K}_2\text{O}$ , 0.08  $\text{P}_2\text{O}_5$ , 1600 I. U. Vitamin A, 10 I. U. Vitamin B<sub>1</sub>, and 70 mg per 100 gr fresh, Vitamin C. (Voedingstabellen door Pannekoek-Westenburg, Nyholt en van Veen, Geneeskundig Tydschrift voor Nederlandsch-Indie, Afl. 33 Deel 80, 1940.)

Small quantities of seed are already available for Florida growers who will

give the plant a fair chance as a vegetable. Horticulturists will find that the size of the leaves often varies with the habitat and with the quality and composition of the soil. The seeds are minute but may be collected without difficulty. They should be sown in dense rows about 8 inches apart. Seedlings of from 6 to 8 inches in height are best for commercial purposes.

It is advisable to keep the plant separate from *Amaranthus spinosus*, Linn—usually called thorny Amaranth, which grows wild all over Florida. Thorny Amaranth is a weed native to tropical America which has spread all over the tropics. Of this species, Burkill says: "It tends to become the commonest amaranth in any thickly populated tropical country, by selection, animals eating it less than the thornless species: and that is why it is the most abundant species in India, and why it is growing increasingly abundant in the Peninsula."

## THE PERFORMANCE OF NEW CUCUMBER VARIETIES

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Bradenton

The growing of cucumbers has been an important phase of Florida agriculture for many years. This crop has been grown commercially to some extent in nearly every agricultural county, and on every type of soil in Florida except possibly the muck and marl areas of the Glades. However, the major portion of the crop has been grown along the west

coast of Florida from Ft. Myers to Ruskin and extending into the interior 50 or 60 miles to the Wauchula and Arcadia areas, thence jumping north to the section west and southwest of Leesburg around Coleman, Bushnell, Webster, and Center Hill. During the past season considerable acreages have been planted to cucumbers in the Ft. Pierce and Immokalee sections. These areas will probably increase greatly the acreage planted to the crop in the future.

Plantings begin for the most part in September, for the fall crop, though a few growers start as early as the middle of August. The spring crop is planted

during late December through early February. The soils, weather conditions, and methods of cultivation, therefore, vary considerably between sections.

It is interesting to note that the individual farm acreage devoted to this crop in these areas will average much less than 5 acres. The large farms are to be found largely in the Ruskin and Ft. Myers sections and more recently in the Ft. Pierce and Immokalee areas where plantings of 50 to a 100 acres are common. Although the growers in the cucumber-growing area from Ft. Green to Arcadia, Bushnell, and Webster section farm much less than 5 acres, the combined acreage from these areas is considerable, as is shown by the hundreds of cars of cucumbers moved during the comparatively short seasons. In spite of the addition of large acreages, the average grower will continue planting just about the amount he and his family can handle.

Since cucumbers are grown in Florida during the winter, temperatures, length of day, and other factors are different from those under which the crop is normally grown. The plants response to environment is reflected in plant growth, flower production, and fruit set. In addition the crop is subjected to the hazards of plant diseases, which are often favored by the climatic conditions which inhibit the normal growth of the plants. No doubt, the most destructive of these diseases is downy mildew with which most of you are familiar. Other diseases of the crop are angular leaf spot, mosaic, bacterial wilt, and powdery mildew, all of which demand considerable effort to control when present in the field. This control is often through laborious application of fungicides by hand-powered

equipment because, as shown above, farmers tilling small acreages cannot afford the costly equipment required on the larger farms. Mention is made of these points to give a better perspective of the value of new varieties having resistance to disease, thereby decreasing the cost of production, which may in turn permit the small grower to increase acreage and family income.

In an effort to reduce the hazards of producing the cucumber crops and reduce the cost of disease control, several new varieties and hybrids of cucumbers have been secured for trials in Florida. Generous samples of downy mildew-resistant lines have been secured from Dr. W. C. Barnes of the Clemson College Truck Experiment Station at Charleston, S. C., for distribution and trials in Florida. Unfortunately the seed supply of some of these lines has been small and distribution has been limited mostly to experiment station workers and a few key growers where performance could be observed during the season. However, these and other new varieties have been tested extensively over most of the cucumber-producing areas of Florida as well as most of the other States in the Southeast during the past 3 or 4 years. Recorded yield data and comments from these sources have been most encouraging. Inasmuch as the new varieties originated at the South Carolina Station are of immediate interest, a short history of their development may be of interest.

These lines are the result of crosses made in 1943 between Puerto Rico 40, a short-fruited, downy mildew-resistant variety originating in Puerto Rico, and the variety Cubit, a long-fruited, susceptible variety. From subsequent generations of this cross several very promising



TABLE 1  
CUCUMBER VARIETY TRIALS—VEGETABLE CROPS LABORATORY—SPRING 1948

VARIETY	Bus. per Acre		Fruit				Early Yield		Vine Vigor	Downy Mildew of Vines Rating 1-5	
	Fancy (No. 1)	Choice (No. 2)	Av. Wt. Fancy	Ave. Length Inches	Color Same, Lighter, Darker than Market	Shape	Date First Harvest	Bu/Acre			
								1			2
1. SC 3	205	61	.67	7.9	Lighter	Fair	4/8	61	18	Good	2
2. Palmetto	217	58	.68	8.1	Same	Good	4/8	58	20	Very good	1-
3. SC 5	249	62	.66	7.9	Same	Good	4/10	62	13	Very good	1-
4. SC 6	213	72	.65	7.3	Lighter	Fair	4/8	72	29	Very good	1-
5. SC 7	177	39	.62	7.4	Same	Good	4/8	39	20	Very good	1-
6. Puerto Rico 39	173	49	.55	6.0	Lighter	Poor	4/8	49	47	Very good	1-
7. Colorado	53	22	.60	8.8	Same	Very poor	4/8	22	15	Good	4
8. Market	151	38	.62	7.6	Same	Good	4/10	38	16	Very good	4
9. Burpee Hybrid	219	82	.66	8.1	Lighter	Good	4/8	82	20	Very good	3
10. Highmoor	101	48	.62	7.2	Lighter	Very poor	4/10	48	14	Poor	5

lines have emerged whose description and records will be discussed in this paper.

All variety testing at the Vegetable Crops Laboratory has been in replicated, randomized plots.

Varieties planted have included the commercial varieties commonly grown in this section: Cubit, Marketer, Abbott & Cobb, and Straight 8; others not generally grown included Long Fellow, Improved Long Green, Colorado, Highmoor and the newer hybrid types; Burpee and Woodruff's Hybrids as well as all of the available downy mildew-resistant lines from the Clemson College Truck Experiment Station. From these lines has been released the new variety, Palmetto, taking its name from the "Palmetto State" of South Carolina.

The early lines received from South Carolina included the numbered strains 201-A-6-7-1-1; 202-1-3 of 1-5; 201-A-61-1-1-2; 201-A-3-7-2-1-2. From these lines emerged the strains later numbered as SC-2, 3, 4, 5 and 6 which were planted in a number of locations over the State to determine whether or not any one of them was better suited to a given locality. From these trials were selected the lines SC 2, 3, 5 and 6 as outstanding, number SC 2 bearing the early number 201-A-3-7-2-1-2 now has been released as the variety "Palmetto" mentioned above.

Descriptions of Palmetto and these South Carolina strains based on observations in field plots at Bradenton are as follows: The vines of Palmetto differ little from those of the commercial variety Cubit except that the leaves are deeply lobed which makes identification of the variety quite simple. The season of maturity is slightly later than Marketer. Fruits produced in trials have been of good quality with a large percentage of fancies in the total yields. Fruit color is good, considered by many as superior to A & C and Marketer. However, the color of the fruit, like most of the varieties tested, varies with weather conditions and is often light green in the fall. The seed cavity of all of the South Carolina lines tested is small.

The line SC-5 is considered by some observers to be superior to Palmetto. It is slightly earlier and tests indicate that it is more productive. The fruit length and shape is not quite as good as Palmetto while the color is nearly the same. The vines are more vigorous and just as resistant to downy mildew, and observations indicate that this line is more resistant to powdery mildew than any of the others.

SC-3 is as early as Marketer and has the fruit shape and vine type of this variety. It is usually rated as intermediate

TABLE 2  
TOTAL MARKETABLE YIELD OF PALMETTO AND MARKETER  
WHEN GROWN UNDER COMMERCIAL CONDITIONS

Farm Location	Palmetto <sup>1</sup>		Marketer	
	Acres	Bu. Per Acre	Acres	Bu. Per Acre
Ritter	17	324	33	36
Yonges Island	4	200 <sup>2</sup>	21	50 <sup>2</sup>
James Island	4½	182	15½	72

<sup>1</sup>Part of these acreages were breeding lines similar to Palmetto.

<sup>2</sup>Based on grower's observation rather than packinghouse records.

in resistance to downy mildew. According to reports this line does well in some sections. In our trials, it has been light of color, yielded less than the other lines, and has shown less resistance to downy mildew. However, according to Dr. Barnes, there is some indication that this line has some resistance to angular leaf spot which would be of great value in some sections where this disease is especially destructive. SC-6 is productive, early, and shows about the same resistance as SC-5. The fruit is blocky and somewhat short for the ideal market type. Color of this line has not been as good as the others but a new selection of this number in trials this season promises to be better than the old line.

Descriptions of the commercial varieties named above are familiar to most growers and need not be included here. Experience with the new variety "High-moor" last season indicates that it is not adapted to the particular requirements of the Florida west coast area as few marketable No. 1 fruits were harvested from this variety. However, it is claimed that it is scab resistant and may be worthy of further trials where this disease is prevalent and serious.

Unfortunately no description can be included of the varieties Colorado and Woodruff's Hybrid which were included in trials during the past two seasons. For some unexplained reason, the Woodruff's Hybrid produced a total of only four fruits in tests in two locations, Bradenton and Ft. Myers. Colorado produced mostly crooks and culls from these plantings.

Growing conditions in the Bradenton area during the past several seasons have left much to be desired and the plantings have suffered from too much water. However, each season a sufficient number of the plots have been salvaged to present a fair picture of fruit type and color, and yield records have been sufficiently complete to give a comparison of the varieties tested.

The variety Puerto Rico 39 has been included in all tests. This variety is extremely resistant to downy mildew and has been used to indicate the comparative resistance of the other varieties grown. This variety has consistently produced the greatest number of fruit, but unfortunately the fruit produced are not uniform as to size and shape, producing a great many very short blocky

TABLE 3  
ESTIMATES OF DEFOLIATION OF CUCUMBER VARIETIES  
BY DOWNY MILDEW<sup>1</sup>

Variety	Per Cent Defoliation		
	Virginia (July 18, 1947)	South Carolina (Oct. 20, 1947) Expt. 1	Expt. 2
Palmetto	44	25	25
Burpee Hybrid	75	60	80
Marketer	—	95	98
A and C	82	95	98
Cubit	91	97	99

<sup>1</sup>Similar Results have been recorded at Charleston in other years and in Florida.

Tables 2 and 3 are reprints from Proceedings of the American Society for Horticultural Science Vol. 51, 1948, W. C. Barnes.

fruit averaging about six inches in length, and not acceptable for the market during the regular season. In our trials the color has been dull green or gourd-like with a great deal of white flecking. This variety is often grown as an "off season" crop for local or nearby markets with success because of its extreme resistance to "downy mildew."

The Burpee Hybrid variety is extremely productive, ranking with the top group for yields of fancy fruits in all of the tests conducted. The vines are extremely vigorous and seem literally able to grow fast enough to produce leaves latster than downy mildew can destroy them. However, in spite of the fact that this variety seems to be quite resistant to the disease because of its vigorous growth, it is fairly susceptible when attacked by the disease in the early stages of growth, and a grower might find it difficult to get control of the disease by spraying or dusting. On the other hand, once this variety has produced a fair sized vine it can stand many reverses and poor growing conditions. The writer, at this time, has plots of this variety that are far ahead of all others in volume of growth though they have been subjected to nearly 17 inches of rain since they were planted.

Fruits of Burpee Hybrid are usually of good size, averaging about the same as Palmetto. The color is good, though tending to be quite light in the fall. Development of the fruit must be watched quite closely in this variety for a mature fruit missed in one picking is sure to be a jumbo in the next. Because this variety is a first generation hybrid, cost of seed is greater than regular varieties. Through spot planting a saving could be had that would permit the use of the seed. It is possible, of course, that cost

of producing this seed may be reduced in the future, thereby reducing cost to the grower.

Table 1 shows the comparative yields and other information of interest taken from the variety trials in the spring of 1948. Previous records and observations on these varieties have been consistently similar to Table 1. Yields on most of the South Carolina lines have always been superior to the commercial varieties tested except Burpee Hybrid and Puerto Rico 39, under like conditions. Continued selections from these hybrids may in the future produce even more satisfactory varieties.

It is possible that these yields from disease-resistant lines would have been even better had they been planted in fields isolated from varieties badly infected with downy mildew. Spectacular yield records have been reported from other sections of the South where these lines have been grown as regular field crops adjacent to commercial varieties. An example is shown in Table 2. These records may be considered as rather extreme differences which happened under extreme conditions but they indicate the value of disease-resistant varieties. This difference is further demonstrated in Table 3 which shows a comparison percentage of defoliation from several experiments in three locations.

Conditions experienced in trials conducted by the writer have never been as extreme as indicated by these tables but results obtained under severe disease conditions have been comparable and most satisfactory.

#### SUMMARY

The introduction of downy mildew-resistant varieties of cucumbers that are adaptable to Florida conditions and pro-

ducing fruits that will compare or excel those of the commercial varieties now in use will remove in large part the greatest hazard in the production of cucumber in the early producing sections of the State. The resistant variety Palmetto and the other sister lines which have been tested no doubt can be grown under the most favorable conditions without the benefit of fungicide protection. However, under most conditions, the writer does not recommend the complete discontinuance of a regular spray or dusting program, especially if exposed to infection from nearby fields. The frequency of applications can be reduced if the plantings are fairly distant from others where susceptible varieties are grown which could be a source of infection.

It is certain that these varieties will be planted extensively as soon as sufficient seed becomes available to supply the de-

mand. Results of tests indicate that Palmetto can be planted with the assurance of a good commercial crop, as it produces good yields of excellent fruits acceptable on all of the markets on equal terms with the commonly grown varieties. Because of the disease resistance of these varieties, picking can be extended from one to several weeks longer than with the susceptible varieties.

Burpee Hybrid has been found to be outstanding in production of exceptionally fine fruits. It is extremely vigorous of growth, but rather susceptible to downy mildew. Chief objection to the planting of this variety is the high cost of seed.

The varieties Marketer, A & C and Straight 8 are still grown extensively in the cucumber growing areas. The variety Marketer is still the favorite of most of the growers in the Bradenton area of the west coast.

## INVESTIGATIONS ON THE CONTROL OF THE FALL ARMYWORM AND THE CORN EARWORM ATTACKING SWEET AND FIELD CORN IN THE EVERGLADES AREA

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The fall armyworm, *Laphygma frugiperda* (S. & A.) and the corn earworm, *Heliothis armigera* (Hbn.) constitute the most serious insect pests attacking corn in the Everglades area. Seldom is a corn crop planted which escapes a severe infestation of one or both of these pests. Other insects which are quite

severe in certain instances include cutworms, wireworms, and the lesser cornstalk borer. A series of experiments for the control of fall armyworms attacking the buds of corn and corn earworms has been conducted at the Everglades Experiment Station during the last few years. The results of these experiments are discussed and some of the more pertinent data are presented.

### THE FALL ARMYWORM

This insect is a pest on both field corn

and sweet corn, but is more destructive on sweet corn. The adult moth deposits egg masses on the leaves of the plant soon after the plant emerges. From the eggs numerous tiny larvae hatch and begin feeding upon the leaves, later to migrate into the buds of the plants. As the larvae become larger, they penetrate deeper into the buds of the corn, sometimes killing the plant, and always making chemical control more difficult. When the larvae mature, they migrate to the ground and form the pupal stage in the soil. The moths emerge from the pupae, thus completing the cycle.

If eggs are deposited late in the growing period, this cycle is not completed before the tassels and silks form, and the worms feed upon the tassels and migrate into the young ears, entering through the tips, or from any point on the sides or butts. When the worms are prevalent at this stage of growth they damage the ears of corn very severely. Fall armyworms sometime migrate into corn plantings in large numbers from adjacent weeds and grasses, and assume real armyworm habits of completely destroying the plants as they pass through them. This form of damage is quite dif-

ferent from the more common budworm type of fall armyworm damage and requires immediate and thorough treatments in order to prevent total destruction of the crop.

A number of baits, sprays, and dusts have been tested against budworms at the Everglades Experiment Station during the past 3 years. The data obtained from two of these experiments are included in order to show (1) the comparative effectiveness of dusts, sprays, and baits, and (2) an evaluation of some of the newer insecticides as controls for budworms. Reference to other experiments is made in the discussion following Tables 1 and 2.

*Experiment A.* U.S. 34 sweet corn was planted in a replicated and randomized experiment in the spring of 1946. Treatments were applied 21 days following planting, using a wheelbarrow-type power sprayer at 200 pounds pressure to apply the sprays, and a rotary hand duster to apply the dust formulations. A list of the various formulations of DDT used in this experiment are included in Table 1 with control data showing the difference in control obtained with sprays and dusts.

TABLE 1  
THE EFFECT OF SEVERAL FORMULATIONS OF DDT ON FALL ARMYWORMS IN THE  
BUDS OF CORN

Treatment	Mean percent of buds damaged 8 days after treatment.
1 - DDT emulsion - 1 pound DDT per 100 gal.	4.4
2 - DDT wettable - 1 pound DDT per 100 gal.	6.4
3 - DDT dust - 3 percent in sulfur	22.1
4 - DDT dust - 3 percent in talc	25.5
5 - DDT dust - 1 percent in talc	43.7
6 - Check, not treated	43.8
Difference required for significance	4.9

*Experiment B.* In the spring of 1948 a planting of Big Joe field corn was used for a replicated and randomized experiment comparing several spray and poisoned bait formulations for the control of fall armyworms in the buds of the corn. Spray treatments were applied using a power sprayer with a three-nozzle boom operating at 200 pounds pressure and delivering about 125 gallons of spray per acre. Baits were applied by hand, dropping a small amount into each bud.

The first applications were made when the corn was 16 inches tall at which time almost 100 percent of the buds were infested with worms. A second treatment was applied 6 days following the first. Control data was obtained 4 days following each treatment. The list of materials applied and degrees of control obtained are included in Table 2.

*Discussion of results obtained from*

*fall armyworm trials.* A study of Tables 1 and 2 will show that poisoned baits were most effective in budworm control, followed by sprays and dusts in the order named. This order of effectiveness has been generally consistent in all of the trials conducted during the last 3 years. On very young corn poisoned baits have not been as effective as on larger corn, for example, a cryolite-corn meal bait applied to corn 21 days after seeding was inferior to DDT sprays, but was superior to cryolite dust or spray. The same type of bait applied to corn 58 days after seeding was superior to DDT sprays, with almost complete eradication of budworms. As the worms migrate from the leaves into the buds and feed deeper into the whorl poisoned baits become more useful. There is some evidence that baits applied to large corn from airplanes may give effective control of budworms, but

TABLE 2

THE EFFECT OF SPRAYS AND BAITS FOR THE CONTROL OF FALL ARMYWORMS IN THE BUDS OF BIG JOE FIELD CORN

Material Applied	Formulation	Mean percent of buds damaged	
		4 days after first treat.	4 days after second treat.
1 - DDT - 50 percent	2 lb. per 100 gal.	29.7	4.6
2 - Methoxychlor - 50 percent	2 lb. per 100 gal.	40.2	8.9
3 - DDD - 50 percent	2 lb. per 100 gal.	32.7	9.5
4 - Parathion - 15 percent	1 lb. per 100 gal.	36.3	9.3
5 - Parathion - 15 percent	½ lb. per 100 gal.	39.7	11.4
6 - HCH - 6 percent gamma isomer	4 lb. per 100 gal.	33.6	13.5
7 - Chlorinated camphene			
25 percent	4 lb. per 100 gal.	28.5	7.4
8 - Chlordane - 50 percent	2 lb. per 100 gal.	22.9	7.3
9 - DDT - wheat bran	5 percent DDT	35.5	6.5
10 - Chlordane - wheat bran	5 percent chlordane	19.0	2.8
11 - Parathion - wheat bran	1.5 percent parathion	13.4	0.0
12 - Check, not treated		95.3	80.5
Difference required for significance		8.7	7.2

this method of application is somewhat inferior to hand applications.

Sprays have consistently given satisfactory budworm control when the application was thorough. On young corn numerous worms are scattered over the leaves and in the buds. All leaves and buds must be thoroughly covered with spray if a high percentage of these worms are to be killed. On larger corn, after the worms have migrated into the buds most of the spray should be directed in the whorl. A power sprayer is needed for best control. It is difficult to obtain maximum control with a knapsack sprayer, requiring very careful and thorough operation. The use of a power sprayer with 3 nozzles per row operating at about 300 pounds pressure and delivering 50-100 gallons of spray per acre will give good control of budworms. The results obtained with dusts indicate that they are inferior to baits and sprays against budworms. Ground powered clusters are fairly effective and may be used if spraying is not possible. The dust also should be directed into the buds.

As noted in Table 2 several insecticides have been found effective against budworms in corn. The grower should first make certain that he has equipment suitable for thorough treatment and then select the material which fits his particular need. Cost of the insecticide would certainly be one consideration. If corn leaves are to be fed to livestock methoxychlor or DDD may be used since they are reported to be less toxic to warm blooded animals. Those with small acreages which do not justify the purchase of powered sprayers may elect to spray or dust young corn with hand equipment and use a poisoned bait after the worms have migrated into the buds.

#### THE CORN EARWORM

The corn earworm is the most serious insect pest attacking sweet corn, and has proven to be a very difficult insect to control. Some common varieties of field corn have been selected for resistance to earworms, and the use of resistant varieties has made chemical control unnecessary. Even on susceptible varieties of field corn it is doubtful that chemical control would prove economically feasible. On sweet corn, however, intensive control measures are often necessary if a high percentage of marketable ears is to be obtained. The adult moth deposits eggs singly upon the corn silks from the time the silks first appear until they have turned brown. Tiny worms hatch from these eggs and migrate into the tips of the ears, feeding upon the silks and then into the tips of the ears. The degree of damage depends upon the variety of corn, the rate of infestation, and chemical control measures used. At the time of harvest many of these worms may be found feeding deep into the ears, making the corn undesirable for marketing.

Corn earworm studies at the Everglades Station have provided the basis for evaluation of a number of insecticidal dust and atomized oil spray formulations applied to the silks, and several mineral oil formulations which were injected into the tips of the ears. Data obtained from experiments conducted in the spring of 1948 are reported.

*Experiment A.* An experimental planting of Ioana sweet corn designed to compare the newer insecticide dusts and one atomized oil-based DDT spray was made in the spring of 1948. Dusts were applied to the silks at the rate of about 35 pounds per acre with a rotary hand duster. The oil-insecticide plots



were treated with a Cornelius Hydraulic Aerosol hand sprayer delivering 0.6 cc. of spray in the silk area from each side of the row. The first treatments were applied when the silks began to show, and additional applications were made at 3-day intervals until a total of six treatments were applied. The corn was harvested on two dates, and a sample of 20 ears of corn from each plot was examined for earworm damage during the first harvest. Yield data and a record of worm damage under the various treatments is contained in Table 3.

portunity to obtain additional data. The experiment was designed to determine the proper timing of oil spray treatments and the number of treatments required for satisfactory control. Treatments were applied with a Cornelius Aerosol hand sprayer, directing the spray from one side of the rows, and delivering 0.6 cc. of spray in the silk area of each ear. The ears of corn were examined for earworm and oil spray damage 20 days following the last treatment. Table 4 shows the time and number of treatments applied, and the percent of worm

TABLE 3

CORN EARWORM CONTROL STUDIES, AMOUNT OF EARWORM DAMAGE AND HARVEST DATA

Treatment	Amount of damage due to corn earworms.		Total harvest (Pounds per 315 feet of row)
	Score <sup>1</sup>	Percent worm free	
1 - Chlordane - 3 percent	199	6	246.6
2 - Methoxychlor - 3 percent	194	3	237.1
3 - DDD - 5 percent	141	23	253.7
4 - DDT - 5 percent	116	39	236.9
5 - Chlorinated camphene - 5 percent	203	2	269.6
6 - Parathion - 1 percent	146	21	229.5
7 - DDT - oil based - 2.7 percent DDT <sup>2</sup>	0	100	249.5
8 - Check, not treated	218	1	242.1
Difference required for significance	23		(not sign.)

<sup>1</sup> A scoring system was used as follows: 0, no worm damage; 1, less than 1 inch of tip damaged; 2, 1 to 2 inches of tip damaged; 3,

over 2 inches of tip damaged. Total score for 100 ears is shown.

<sup>2</sup> Shell Vapona D-42 supplied by Shell Oil Company, Inc.

*Experiment B.* In order to obtain additional information on the atomized oil-based DDT treatment further experimentation was conducted on Big Joe field corn. While this corn is not seriously affected by corn earworms, it was selected because the planting was near the silking stage at the conclusion of the previous experiment, and offered an op-

portunity to obtain additional data. The experiment was designed to determine the proper timing of oil spray treatments and the number of treatments required for satisfactory control. Treatments were applied with a Cornelius Aerosol hand sprayer, directing the spray from one side of the rows, and delivering 0.6 cc. of spray in the silk area of each ear. The ears of corn were examined for earworm and oil spray damage 20 days following the last treatment. Table 4 shows the time and number of treatments applied, and the percent of worm

*Discussion of results obtained from corn earworm trials.* Using the scoring system outlined in the footnotes below Table 3, the 5 percent DDT dust was found to be superior to the other dust treatments in reducing earworm damage. Five percent DDD and 1 percent para-

TABLE 4

CORN EARWORM CONTROL - TIME AND NUMBER OF TREATMENTS WITH ATOMIZED OIL BASED DDT<sup>1</sup>

Treatment No.	Date of treatments <sup>1</sup>			Percent of tips free of worm damage
	May 25	May 29	June 3	
1	X	X	X	89.1
2	—	X	X	90.0
3	—	X	—	57.2
4	—	—	X	92.0
5	—	—	—	38.8
Difference required for significance				14.6

<sup>1</sup> The formulation used was Shell Oil Company's Vapona D-42.

"X" indicates the treatment was applied.

"—" indicates the treatment was not applied.

thion dusts were inferior to the 5 percent DDT dust, but were superior to 3 percent chlordane, 3 percent methoxy-chlor, 5 percent chlorinated camphene and the check.

The complete absence of earworm damage in the atomized oil-based DDT spray plots was a striking contrast to the best dust treatment which produced only 39 percent worm free ears. The six atomized DDT oil treatments produced definite injury to the tips of the ears in preventing kernel formation for from 1 to 3 inches on many of the ears. This tip damage was quite similar to damage resulting from mineral oil-pyrethrum injection treatments. The total absence of worms in this oil spray treatment was interpreted to indicate excessive treatments, and Experiment B was conducted to obtain information on timing and number of treatments required for good commercial control of earworms.

The data contained in Table 4 definitely indicate that timing of the oil spray treatments is an important factor in control of earworms by this means. The plots receiving the last (June 3) treatment were equal in worm-free ears to the plots receiving the last two, and to those receiving all three treatments. There was some evidence of treatments 1, 2 and 4 in Table 4 preventing kernel formation on the tips of some of the ears. Later studies (not reported in this paper) indicate that excessive tip damage may be avoided by proper timing and a change in spray formulations. While the studies with oil-based sprays for treating corn earworms are not complete, this method of control shows more promise as a practical means of obtaining a high percentage of worm-free ears than any treatment yet tested at the Everglades Experiment Station.

# RECENT PROGRESS IN BREEDING TOMATOES FOR DISEASE RESISTANCE

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## 1. INTRODUCTION AND HISTORICAL BACKGROUND

At the meeting of this Society in 1942, Dr. Beckenbach presented an account of the work of our laboratory on this problem. His report was to a considerable extent a projection of the problem—a statement of what the laboratory proposed to do because of the need for varieties of tomatoes resistant to the several diseases that were regularly causing the growers of the State severe losses. The purpose of this paper is to report, in as much detail as the allotted time will allow, our present position on each phase of this work.

The diseases of tomato that have been given attention in this breeding program are as follows:

1. Wilt, caused by *Fusarium oxysporum* Schlecht var. *lycopersici* Sacc.
2. Mosaic, caused by two or more tobacco mosaic viruses.
3. Collar-rot and early blight, caused by *Alternaria solani*.
4. Root-knot, caused by nematodes known as *Heterodera marioni*.
5. Gray leafspot, caused by *Stemphylium solani* Webber.
6. Leaf mold, caused by *Cladosporium fulvum* Cke.

These diseases are listed in the order of the share of time apportioned to them

during recent years. At the outset, of course, Fusarium wilt and mosaic were the only two diseases in the program. The others were added to the list only upon the demonstration, mostly by other experiment station workers, of course, that inherent resistance to them occurs in some species, variety, or line of tomato. In each case, stocks of the lines possessing the desired resistance have been acquired, subjected to repeated tests in our fields in which tomatoes are grown crop after crop, and, if they showed promise, used for crossing with the most advanced stocks already on hand. Very recently bacterial wilt, caused by *Phytophthora solanacearum*, has been added to our program. This disease is currently causing severe losses in several old fields of the West Coast district of Florida. We are at present looking for resistance to Phoma, a fungous disease affecting leaves, stems, and fruits. The developments of the past few crops in our section indicate that Phoma resistance will be especially important if tomatoes are to be prepackaged in Florida.

For some time it has been the view of the laboratory that a new tomato variety must have resistance to several diseases if it is to be suitable for use on old land and enable the grower to avoid the heavy expense of clearing new land for each crop or for only two crops. Thus, the breeding problem has become one of combining, in a few new varieties, the resistances to all the major diseases. Disease resistance is not enough in itself,

of course. We must select for fruiting characters such as number, earliness, size, smoothness, shape, and quality at every possible opportunity. Dr. Beckenbach has set as the goal of this project new varieties equal to Rutgers in vigor, adaptability, and yield, superior to it in earliness, smoothness, quality, and disease resistance.

## II. NEW VARIETIES

The Vegetable Breeding Laboratory, U.S.D.A., Charleston, S. C., about 3 months ago released a wilt and collar-rot resistant tomato variety under the name Southland. This variety is also reported, by some observers, to show resistance of worthwhile degree to late blight, but I shall have to see this before I accept it as fact. However, the line has made a favorable impression upon everyone in Florida's Experiment Station system who has tested it. This new variety merits trial by numerous growers who are operating on old land, but seed will probably not be available until next summer.

As many of you know, our laboratory at Bradenton in July sent out, for trial by growers throughout the State, two lines that have given promising performances in our area. These two releases are tentatively assigned the names of Manasota and Manahill. Manasota possesses the field immunity to Fusarium wilt, is early, and produces numerous medium-sized, high-quality fruits. It has been carefully selected through several successive generations by Dr. Beckenbach for the horticultural characteristics after showing itself homozygous for wilt resistance. Manahill possesses the same level of resistance to wilt and produces numerous large fruits of good quality, but it is a few days later than Manasota and may

not be so well adapted for the fall crop. However, Manahill has, in combination with the wilt resistance, the best available level of resistance to collar rot and early blight, plus the highest order of resistance to gray leafspot. The pedigree of Manahill is before you because we think you might find it interesting and enlightening.

## III. WILT RESISTANCE

With few exceptions, the numerous breeding lines we are now handling are homozygous for the "Pan America" type of resistance to Fusarium wilt, commonly described as field immunity. The original stocks carrying this resistance, which was found in the South American species of cherry tomato, *Lycopersicon pimpinellifolium*, were supplied by Dr. Tucker of the University of Missouri, who had carried out the tedious work of advancing this resistance several steps from the semi-primitive early hybrid form toward the desired goal by backcrossing the resistant hybrids to the best commercial varieties. Dr. A. L. Harrison, who handled the project for 3 years, did much of the work required on this phase.

## IV. COMBINATION OF WILT RESISTANCE WITH RESISTANCE TO ALTERNARIA AND STEMPHYLIUM

The pedigree of Manahill shows one of several courses pursued in the efforts to combine wilt resistance with resistances to collar rot and early blight. The line CR-1 used as the source of collar-rot resistance in the last cross was supplied by the regional VBL, at Charleston. For crossing with this line Dr. Harrison happened to choose plants of line W41-3-2 carrying the recessive genes accounting for a very high resistance to gray leafspot

(*Stemphylium*). Though he left no record on the point, we can be sure that Dr. Harrison chose plants of W41-3-2 that were free from the leaf spots occurring at the time.

The epidemic of gray leafspot that developed in November of 1947 did us the service of causing each of numerous breeding lines to clearly show its reaction to the causal fungus. We now feel that we are in very good position with respect to this disease, which has been a constant threat to the tomato crop in Florida. We have on hand lines derived from other source stocks that show resistance to gray leafspot and we now believe that we recognize at least two, possibly three, levels of resistance to the disease, that shown by Manahill being of the higher order and amounting to practical field immunity.

Though we have had no epidemic of early blight during the past four crops while selections resulting in Manahill and its sister lines have been in progress, we feel reasonably certain that these lines possess a meritorious level of resistance to early blight. This opinion is based partly on the results of a small-scale inoculation test, partly on field observations. We have on hand certain breeding lines with a recognizably higher level of resistance to early blight, and knowing that Manahill and its sister lines are not resistant to other important leafspot diseases, we have made crosses designed to incorporate these desirable resistances with the promising features of Manahill.

#### V. MOSAIC RESISTANCE

The demonstration of useful hereditary resistance to mosaic has presented more difficulties than have been encountered

in connection with diseases due to fungi. One reason for difficulty with this phase of the problem is the impossibility of readily classifying inoculated plants on the basis of symptoms. A more important source of confusion is the fact that mosaic comprises several hardly distinguishable virus diseases and that these occur in numerous varieties, strains, and combinations. Recent study of the problem at our laboratory suggests that the genes for resistance (known in the case of tobacco mosaic to be tolerance of the nonsymptomatic type) are different for the different types of mosaic.

Beginning with the spring crop of 1947, the virus stocks used for routine testing of tomato populations for reaction to mosaic were restricted to two strains of tobacco mosaic, which, in combination, give readily recognized calico patterns in tomato leaflets. A few single-plant selections taken from segregating populations of that crop have bred true through the next two generations for freedom from mosaic symptoms, all plants in each crop being inoculated four or five times with the same combination of viruses. This is believed to be the longest forward step thus far taken in breeding tomatoes for mosaic resistance. However, we now know that these lines showing this particular resistance are not resistant to another virus stock collected from a diseased tomato plant at the laboratory. Neither are they resistant to the virus disease that caused such heavy losses in the Homestead district in 1948. I am indebted to Dr. Conover for the latter information.

*L. hirsutum* is the source of this resistance or tolerance.

## VI. COMBINATION OF MOSAIC (TOBACCO) RESISTANCE WITH RESISTANCES TO WILT AND GRAY LEAFSPOT

Repeated selections from lines grown on old land have no doubt been a contributing factor in bringing us to the stage that lines in stock for study of mosaic reaction are, without exception, resistant to wilt. The severe outbreak of gray leafspot in November 1947 made it possible to select for resistance to this disease among the lines and segregating populations carrying the tolerance for the particular tobacco mosaic strains described in the preceding section. We feel fortunate in having on hand at present three lines that possess, in combination, the resistances to wilt, gray leafspot, and tobacco mosaic.

## VII. LEAF MOLD RESISTANCE COMPLICATED BY AUTOGENOUS NECROSIS

Leaf mold, caused by the fungus *Cladosporium fulvum* Cke., is sometimes very damaging to tomatoes in Florida when spells of damp weather, such as that we have recently experienced, occur. Resistance of a promising nature became available in 1945 and was added to our breeding program, though not given any greater share of time than required to make a few crosses. When the opportunity arose during the wet season of the autumn of 1947 to select accurately for resistance to this disease among the lines to which the dominant resistance had been introduced, it was found that we possessed just one F3 line that was uniform for resistance and at the same time free of the autogenous necrosis that occurs with the resistance (and is worse than the disease) unless prevented by another gene lacking in *L. esculentum*.

The latter gene is not linked with the gene for leaf-mold resistance, so the

problem of combining this desirable resistance with the other resistances becomes one of selecting from hybrid populations the one plant in 16 that is homozygous for both dominant genes. If we could operate with unlimited space and help, this would present no problem. As we are situated, we shall need either a stroke of luck or considerable time to reach the objective. (As you know, however, such problems are not recognized as deterrents by the plant breeder.)

Both genes concerned in this resistance are native to *L. pimpinellifolium*, the cherry tomato. Numerous crosses have been made during the past year for the purpose of adding this resistance to the stocks possessing the combined resistances mentioned earlier.

## VIII. THE PRESENT OUTLOOK ON RESISTANCE TO ROOT-KNOT

Some years ago an introduction of the very small-fruited Peruvianum tomato was reported to be resistant to rootknot, and several laboratories immediately began efforts to transfer this resistance to our commercial tomato. Despite incompatibility between the markedly different species, and sterility of the laboriously produced hybrids, plant breeders have worked away at the problem hopefully and have generously shared their stocks as each small gain has been made. At the moment, however, we are not certain what to think about this phase of the problem, the reasons for the uncertainty being as follows:

1. In our testing of lines, which is done on the same infested land crop after crop, no line has shown uniformity for freedom from rootknot during the past three crop seasons. Several lines have yielded a few plants that showed

no galls on their roots, but no such selection has shown, in following generations, promise of immunity from root-knot. This applies to selections of the introduced species *L. peruvianum* as well as to hybrid stocks.

2. Dr. V. M. Watts, of the University of Arkansas, who for sometime has been at the forefront in breeding tomatoes for rootknot resistance, was confident he was progressing steadily until this year. In the 1948 crop, several of his lines that had previously appeared immune developed rootknot. Dr. Watts is at a loss to interpret this reversal unless it is explainable by the introduction of different species or races of nematodes to the soil of his testing grounds.

3. The Hawaii Experiment Station, on the other hand, is not troubled by any such reasons for pause. After a period of depression on the project because of sterility of hybrids, workers at that station are now highly hopeful that they will soon have a commercial tomato with rootknot resistance, one of their hybrids breeding true for resistance to the pest having recently proven cross-fertile with commercial tomatoes.

4. Recent developments in the use of soil fumigants suggest that rootknot may soon be controlled economically by application of chemicals that give other beneficial effects.

At the Vegetable Crops Laboratory we have not discontinued our work toward rootknot resistance. We shall try to obtain new stocks from the Hawaii Station and test them as soon as possible. Recently we have been making crosses with very vigorous breeding lines that

show a partial resistance or tolerance to the disease because of their ability to produce new roots higher on the stem while the nematodes are destroying the older roots. If this superior root producing character can be fixed in combination with other desirable traits it may prove helpful in connection with several difficulties, including the scald of tomato resulting from excessive soil water.

In closing, I would like to report that we have reached the stage in which the cooperation of growers and other interested persons can be very helpful to us in selecting the best and most widely adapted lines from our numerous new forms of tomatoes. We view the two recent releases, Manasota and Manahill, as merely the beginning of an effort to evaluate these new forms. At present we have on hand, and available for trial by any interested grower, several closely related lines that might prove superior to Manasota and Manahill in certain sections or over the entire State, the two lines that were chosen for first trials by growers merely representing our best guesses at the time. It is our hope that these two selections will be thoroughly tested by many growers in all sections of the State and that critical appraisals will come to us in number. There is no doubt that detailed reports on the merits and faults of these new tomatoes will be very helpful to us in choosing related lines and forthcoming products of our breeding program for future trials, thus shortening the time required to determine which new forms to recommend for use in the various districts of the State.

# TOMATO FUNGICIDES AND METHODS OF APPLICATION

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For many years the standard recommendation for control of tomato diseases such as late blight, early blight, and gray leaf spot has been the use of Bordeaux mixture or copper-lime dust. These materials afforded good disease control and were extensively used. It had long been known, however, that the combination of copper and lime had a stunting effect on the tomato plant. Yields from sprayed rows were less than yields from unsprayed rows when disease failed to appear. In the late 1930's there appeared the so-called neutral or inert copper compounds known to the trade as Copper A, Tribasic, Cuprocide, C.O.C.S., etc. These were supposed to be less toxic to the plants while preserving the fungicidal qualities of Bordeaux mixture. These new copper compounds had not been on the market too long before research workers began receiving test samples of a new line of compounds, the organics. Many of these new compounds have been tested on tomatoes under Florida conditions. Some of these have proved to be less toxic to the tomato plant and, at the same time, to be af-

fording better protection from some of the more destructive tomato diseases.

Perhaps the best known of the new organics is Dithane D-14, which is the sodium salt of a complex organic compound furnished to the farmer in liquid form. Two quarts of this liquid put into water with one pound of zinc sulfate and one-half pound of lime (added in that order) form a new compound in which the sodium is replaced by the zinc from the zinc sulfate. Dithane D-14, properly applied as a spray, has given excellent control of late blight at Homestead, Belle Glade, and Bradenton. Experimental and field observations made during the past few seasons at Homestead and Belle Glade indicate that Dithane D-14 controls late blight even during the severe epidemics when the coppers fail to give adequate protection.

Dithane gives excellent control of early blight and gray leaf spot, as well as of late blight. In fact, Dr. Walters, Pathologist at the Bradenton Station, says that during the past two seasons Dithane gave better control of gray leaf spot than Copper A. At Indiantown last year, Dithane was as good as but no better than the ten other fungicides tested and gave significantly better results than the unsprayed check plots. In view of these findings we are recommending the use of Dithane on tomatoes over any other fungicide.

You will recall that Dithane D-14 reacts in the spray tank with zinc sulfate to form a complex zinc compound. There are two fungicides on the market,



which contain this same zinc compound, made at the factory instead of in your spray tank. These are Parzate and Dithane Z-78. These two compounds should be equal to Dithane D-14 in every respect and, in general, experimental evidence bears this out. Unfortunately each in the past has shown variable behavior, and we are a trifle hesitant to give them the same full recommendation given Dithane D-14. These materials have the advantage over Dithane in that there is but one material to put into the tank, saving labor and reducing the possibility of error. On the other hand Dithane is cheaper per 100 gallons of spray.

There is one other organic compound, Phygon, that shows promise as a tomato fungicide. It is a close relative of Spergon, which many of you have used as a seed treatment. Experimental testing of Phygon has not been completed and, at present, we are recommending its use on seedbeds only.

I know that there are some of you who used successfully the copper compounds last year and who are wondering why they have not been given a strong recommendation. There are some areas in the State where late blight and gray leaf spot have not been severe. Indiantown was one of these areas last year, and one of the biggest growers there made a fine crop with Copper A. However, in the Experiment Station plots at Belle Glade late blight was so severe that Copper A did not afford adequate protection and plants sprayed with it died prematurely. Late blight in south Florida seems to be getting worse each year. Since we cannot predict just when and where the disease will reach epidemic form, we must recommend the fungicides which we know will give the best performance under the most adverse conditions.

While it is very important to know just what fungicide will best control a disease or a group of diseases, it is equally important to know how and when to apply this fungicide. Many times a grower has said that a particular material has not worked for him when the root of the trouble was not the chemical but the manner in which it was applied. Let us consider, then, the two important principles of fungicide application. It should be emphasized that neither of these principles is more important than the other; each must be observed equally if the best results are to be obtained.

In the first place, there is timing. Fungicides are preventatives not cures; applications must be started before the disease appears. The fungi that attack your tomato plants live inside the plant tissues where fungicides cannot penetrate. Therefore, the plant must be protected at the surface so that the organism will be killed before entrance can be made. Timing also includes the interval between applications. We know, for instance, that late blight is more severe in cool, damp weather than it is under warm and dry conditions. When weather is not favorable for fungus development, a spray schedule of 5 to 7 days is sufficient. This interval must be shortened to 4 or 5 days when favorable late blight weather is present.

In the second place, we must consider coverage. The fungi causing tomato diseases spread from plant to plant and from field to field by means of spores. Spores are carried, in general, by the wind, and they land at random on the plant surfaces. Once landed, they germinate and send a tube into the tissues. Unlike insects, spores do not move and thereby increase the chances of their

contacting a poison we have left on the plant. We must, therefore, have the plant completely covered with fungicide if these spores are to be killed. We must direct the fungicide at the plant with sufficient pressure to blow the material to the center. We recommend a minimum of 400 pounds at the pump for spray machines. A sufficient number of nozzles must be provided, and the ground speed of the machine should not be too fast. Exact recommendations on these factors cannot be made because of the many variables which enter into the picture, such as the efficiency of the machine and the size of the plants. The grower should check individual plants in the field to make certain that there is visible spray or dust residue on the whole plant including the upper and lower leaf surfaces. He should check this several times during the operation.

You well know the three methods for applying fungicides: Ground spraying, ground dusting, and airplane dusting. We strongly recommend ground spraying, because experience has showed that it is by far the most effective method. Airplane dusting is the least effective of the three. However, at times when the soil is too wet for ground equipment, an airplane should be used for protection until ground applications can be resumed or initiated.

Until varieties of tomatoes which are resistant to the more serious fungus diseases are available, the application of the proper fungicides is as important in the farming operation as land preparation, cultivation, and fertilization. The grower should plan his crop before it is planted so that he has adequate machinery and labor to carry out a proper disease control program.

## CONTROL STUDIES ON THE SERPENTINE LEAF MINER ON POTATO AND TOMATO

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Serpentine leaf miner, *Liriomyza pusilla* (Meig.), infestations, numerous in the 1945-46 season, were destructive in both the 1946-47, and 1947-48 seasons in the southern part of Florida. This fly was destructive to the vegetable crop plants such as potatoes, tomatoes, beans, okra, squash, and cabbage. The degree of destruction varied among fields and crops. Individual potato and tomato plants, for example, were killed by leaf miner attacks. Fields of infested plants

assumed a brownish color in cases, so great was the damage. Cabbage, squash, and beans suffered less injury as a rule than potatoes and tomatoes. These severe infestations have occurred in the cooler months of the year, January, February, and March. Most vegetable production, unfortunately, is coincident with the leaf miner attacks in the cooler months.

Coincidentally or otherwise, the leaf miner was not a serious pest before DDT was used so extensively for control of other insects. It was suggested by Kelsheimer (1948) from observations in Florida and by Jefferson (personal correspondence) in California, that DDT

might be responsible for the leaf miner outbreaks. It is possible that the infestation may be attributed to other, and currently unknown causes.

Effective leaf miner control was reported by Wolfenbarger (1947) in which chlordan, one of the newer insecticides gave good control. The season following these tests (1947-1948) two other new insecticides, chlorinated camphene and parathion, were available and were tested. Tests made with these and other insecticides on potatoes and tomatoes are reported herein.

#### TEST PLOTS AND PROCEDURES

Field plots, each 12 feet wide, 50 feet long for potatoes, and 36 feet long for tomatoes were used for the experiments. The potato plots were four rows, and the tomatoes were two rows wide. The treatments were each replicated four times, arranged in randomized block designs.

All test materials were applied by power sprayer field equipment. The fungicide, dithane, D-14 at 2 quarts, and 1 pound of zinc sulphate per 100 gallons of water was used for control of late blight disease. Lime was omitted from these potato and tomato tests since it is believed to reduce the effectiveness of most of the newer insecticides. The fungicide was mixed according to the usual procedure, then the insecticide was added.

A total of eleven fungicidal applications was made nine of which included insecticides. A total of approximately 1,000 gallons per acre of the insecticide-fungicide combinations was applied during the season.

Large numbers of the serpentine leaf miner adults began invading the potato plots in mid-January. Adults were present on the plants at this time and leaf

punctures symptomatic of the miner were soon observed in large numbers. They were abundant for fully 2 months afterward. In a few days many larval mines were in evidence on the leaves. Between January 20 and 24 swarms of the winged green peach aphid, *Myzus persicae* (Sulz.), settled on the plants. Aphids remained on the untreated plants throughout the remainder of the season. They were not serious on potatoes but became injurious to tomatoes. Other insects infesting the plants were the banded cucumber beetle<sup>1</sup>, *Diabrotica balteata* Lec.; the southern armyworm, *Prodenia eridania* (Cram.); and a few tomato hornworms, *Protoparce quinque-maculata* (Haw.). The serpentine leaf miner, however, was the most injurious insect in all plots.

*Potatoes.* Bliss Triumph potato seed pieces were planted November 26, 1947. Wet soil at planting time and continued rains caused considerable seed piece decay, resulting in poor stands in some plots. This caused unequal yields which in turn caused a larger error value from the statistical analysis and lessened the values of the average yields.

The plants were first sprayed with the fungicide alone on December 30. A week later the insecticides were combined with the fungicide. The next week only the fungicide was used, then applications of the insecticide-fungicide combinations followed at weekly intervals until February 9, after which the interval was reduced to 5 days.

Counts of the leaf mines were made on January 30 and February 16. Four plants or leaves in each plot were used for making each count. These data and the final yield were summarized and are presented in Table 1.

Parathion gave the best control of the

TABLE 1  
AVERAGE NUMBERS OF SERPENTINE LEAF MINES FOR EACH OF TWO COUNT DAYS,  
PERCENTAGES OF CONTROL, AND TUBER YIELDS FROM TREATMENTS

		Leaf mines, counted on				
		January 30		February 16		
Insecticides included with fungicides	per 100 gals.	Avg. No. per plant	Percent control	Avg. No. per leaf	Percent control	Yield, bu. per acre
DDT, 50% wett. <sup>1</sup>	2 lbs.	20.0	22	55.3	30	221
DDT, 25% emul. <sup>2</sup>	1 qt.	25.5	0	77.5	2	278
Chlordan, 50% wett. <sup>3</sup>	2 lbs.	2.8	89	37.0	53	261
Chlordan, 40% emul. <sup>1</sup>	2½ pts.	3.1	88	51.8	34	204
Benzene hexachloride (Isotox), 25% gamma- isomer, wett. <sup>1</sup>	1 lb.	11.4	55	54.5	31	292
Benzene hexachloride (Isotox), 25% gamma- isomer, emul. <sup>1</sup>	1 pt.	3.9	85	42.3	46	284
Chlorinated camphene, 25% wett. <sup>1</sup>	4 lbs.	3.7	85	40.5	55	240
Chlorinated camphene, 60% emul. <sup>4</sup>	¾ qt.	1.8	93	29.0	63	277
Parathion, 25% wett. <sup>5</sup>	2 lbs.	2.2	91	3.3	96	303
Tetraethyl pyrophosphate, 9% (Vapotone) <sup>1</sup>	1 pt.	12.1	51	71.8	8	293
Tetraethyl pyrophosphate, 95% <sup>4</sup>	½ pt.	9.5	63	50.3	36	305
{ Lead arsenate	4 lbs.	17.8	30	51.3	35	280
{ Nicotine sulfate, 40%	1 pt.					
{ DDT, 50% wett.	2 lbs.	6.8	75	47.0	40	286
{ Nicotine sulfate, 40%	1 pt.					
Check (fungicide only)	—	25.5	—	78.8	—	246
Difference required for least statistical significance, at 5% level		8.4	—	17.3	—	Not. sig.

<sup>1</sup>Secured from California Spray-Chemical Corporation

<sup>2</sup>Secured from Rohm and Haas Company

<sup>3</sup>Secured from Dow Chemical Company

<sup>4</sup>Secured from Chipman Chemical Company

<sup>5</sup>Secured from American Cyanamid Company

<sup>6</sup>Secured from Victor Chemical Company  
(Subtropical Experiment Station, Home-  
stead.)

serpentine leaf mines; chlorinated camphene was second best in control. The wettable chlorinated camphene gave some chlorosis of the plants in the first application. The yellowing disappeared, however, with the growth of the plants.

*Tomatoes.* Tomatoes of the Grothen's Globe variety were set in the field on January 24, 1948. Each plot contained 36 plants placed 2 feet apart in the rows. They were sprayed with the fungicide alone on this date and on January 27,

after which they were sprayed with insecticide-fungicide combinations at 5-day intervals. Late blight was generally severe at the time the plants were placed in the field, but was controlled so that it was never an important factor in the experimental plants. Mosaic disease, however, was serious and greatly decreased yields. The serpentine leaf miner was the most serious insect pest. Many

plants in certain treatments were nearly killed by it. The green peach aphid, *Myzus persicae* (Sulz.), increased rapidly to infest the plants, in large numbers. Dry weather and salt intrusion, however, were two uncontrolled factors which combined with mosaic nearly destroyed the experiment as far as yields were concerned. A few tomato hornworms were observed on the check and

TABLE 2  
AVERAGE NUMBER OF LEAF MINES PER TOMATO LEAF, PERCENTAGE CONTROL  
AND YIELD OF MARKETABLE FRUIT FROM THE FIRST TWO PICKINGS

Treatment material	Leaf mines counted on					Fruit, lbs per plot
	Amt. per 100 gals.	No. of mines	Percent control	No. of mines	Percent control	
DDT, 25% emul.	1 qt.	52.3	2	44.5	- 38	12.8
Benzene hexachloride (Isotox), 25% gamma-isomer wett.	1 lb.	27.3	49	43.0	- 33	17.5
Chlordan, 40% emul.	2½ pts.	23.3	56	22.5	30	15.0
Parathion, 25% wett.	2 lbs.	0	100	6.0	81	23.7
Tetraethyl pyrophosphate, 9% (Vapotone)	1 pt.	20.5	62	36.5	- 13	10.8
Tetraethyl pyrophosphate, 95%	¼ pt. <sup>1</sup>	23.8	55	39.3	- 22	1.4
DDD (Rhothane), 50% wett. <sup>1</sup>	2 lbs.	62.3	- 17	58.8	- 82	11.4
Methoxy DDT (Marlate), 50% wett. <sup>2</sup>	2 lbs.	56.8	- 7	48.0	- 49	2.4
DDD (Rhothane), 25% emul. <sup>1</sup>	1 qt.	52.8	1	42.5	- 32	8.3
Methoxy DDT (Marlate), 25% emul. <sup>2</sup>	1 qt.	56.0	- 5	40.8	- 26	2.1
Calcium arsenate	4 lbs.	56.3	- 6	60.0	- 86	7.4
Nicotine sulfate, 40%	1 pt.					
Chlorinated camphene, 40% wett. <sup>1</sup>	2½ lbs.	14.8	72	22.8	29	12.9
Wettable sulfur	2 lbs.					
Chlorinated camphene, 60% emul.	¾ qt.	9.5	82	16.3	50	11.2
Wettable sulfur	2 lbs.					
Check (fungicide only)		53.3		32.3		5.4
Difference required for least statistical significance, at the 5% level		19.3		23.4		12.0

<sup>1</sup>Secured from Rohm and Haas Company.

<sup>2</sup>Secured from E. I. du Pont de Nemours Company.

<sup>3</sup>Secured from Chipman Chemical Company.

<sup>4</sup>The first application was at ¼ pint per 100 gallons but burned the plants so severely they never fully recovered.

(Sub-tropical Experiment Station, Homestead.)

the tetraethyl pyrophosphate treated plots; none on any other plot. Data on leaf mines were taken on two different dates to determine treatment effects. Four leaves in each plot of each treatment were examined on each date. These results and also the yields obtained from the first two pickings are summarized in Table 2.

Parathion gave the most outstanding leaf mines control. Chlorinated camphene was considered to have ranked second in reduction of leaf mines. Chlordan gave some control of leaf mines and yielded more fruit per plot than some treatments, including the check.

Average percentages of leaf mines control for certain insecticides, calculated from data in Tables 1 and 2, are given in summary form as follows:

Chlordan Emulsion	Chlorinated camphene Emulsion	Wettable
52	72	60
Parathion	Benzene hexachloride	DDT Emulsion
92	23	-9

These percentages illustrate the relative amounts of leaf mines control obtained for these materials on potatoes and tomatoes. Aphid control was most effective on plants sprayed with parathion. Chlorinated camphene also gave satisfactory aphid control. Benzene hexachloride (essentially pure gamma-isomer base) gave good control. Aphid control with DDT emulsion was satisfactory.

Yield data from the parathion plant spray treatments were highest with tomatoes and second highest with potatoes. Evidence has been obtained which shows that regular applications of the

phosphatic insecticides, hexaethyl tetraphosphate, tetraethyl pyrophosphate, and parathion, and also of phosphoric acid added to dithane and zinc sulphate, have increased potato yields. A manuscript which was prepared to present this evidence has been accepted for publication in the *Journal of Economic Entomology*, (Wolfenbarger, 1948).

Taste tests and consumption of tomato fruits and potato tubers by members of at least 25 different families from plants treated with chlordan, parathion and chlorinated camphene showed that none detected any off-flavor. Although some tasters detected off-flavor in potatoes from the benzene hexachloride sprays, no off-flavor was detected in tomatoes, even in fruit tasted within a week after spray applications. It is recommended, until more is known about the newer insecticides, that at least 2 weeks elapse between insecticide application and harvest of the tomatoes. This recommendation is given mainly in consideration of the insecticide residues.

Both the older and newer insecticides tested were accepted as poisonous. All were handled alike, without any protective measures, using the same precautionary measures ordinarily exercised in handling spray materials. No injury nor deleterious effect was encountered in testing any of these materials. The 2 pounds dosage of 25 percent wettable parathion used in the experiments is higher than will be generally recommended. In consideration of work done elsewhere it appears that 1 pound of 15 percent wettable powder per 100 gallons of spray and 1 percent of parathion dust will be sufficient. One to one and one-quarter pounds of active ingredient per 100 gallons of spray and a 10 percent dust of chlorinated camphene seems to

be the approximate amount for general recommendation for serpentine leaf miner and aphid control in southern Florida. Late blight disease control was equal in all plots indicating that no insecticide in the combination reduced the efficiency of the fungicide.

#### SUMMARY

The serpentine leaf miner has been present and serious for the last two seasons on winter vegetable crops in southern Florida. The most outstanding control of leaf mines on potatoes and tomatoes was accomplished by parathion sprays, followed in order by other sprays as listed. Chlorinated camphene ranked second in leaf mines control. Chlordan

was considered to have ranked third in reduction of leaf mines. Yields from parathion treated plants ranked second and first on potatoes and tomatoes, respectively.

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## SOME CAUSES OF LOSSES IN HANDLING POTATOES

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#### INTRODUCTION

Spoilage occurring during the process of marketing early Irish potatoes in the Southeastern States is the cause of considerable loss each year to potato shippers, transportation agencies and receivers in terminal markets. Such loss results in a lower price being paid to producers and a greater cost to consumers for potatoes. Because of the regional scope of this problem, and the impossibility of a successful study of the factors responsible for spoilage by any one State, the five Southeastern States of Florida, Alabama, South Carolina, North Carolina, and Virginia are engaging in a cooperative research study of this factor under the Research and Marketing Act. The objectives of the study are:

- (1) To determine factors causing spoilage in Marketing early Irish potatoes;
- (2) To determine extent of damage caused by various factors;
- (3) To determine economic losses resulting from the various types and severity of spoilage; and
- (4) To experiment with ways and means to reduce spoilage.

The States are being assisted in the work by the Bureau of Plant Industry, the Bureau of Agricultural Economics, the Railroad Perishable Inspection Agency, the Western Weighing and Inspection Bureau and cooperating shippers, receivers, and farmers in various potato-producing areas.

This study is unique in that the marketing of potatoes is followed from the time they begin to move in volume from Florida until the deal is over in Virginia. The same research crew follows the movement from State to State and col-

lects certain desired information on harvesting, grading and packing, and marketing practices. This makes it possible for one State to profit from the results obtained in another State.

Work on the study was begun in 1947 when a pilot study was conducted in North Carolina and Virginia to try out schedules and procedure for obtaining the desired information. In 1948, the work was carried on in all the States. Areas studied in Florida were Dade County and the Hastings area; Alabama, Baldwin and Escambia Counties; South Carolina, Charleston area; North Carolina, Aurora and Elizabeth City areas; Virginia, Princess Anne County and the Eastern Shore.

#### METHOD OF STUDY

To obtain data on the factors causing losses in handling potatoes, arrangements were made with cooperating shippers to follow test lots of potatoes from the time they were dug in the field, through the grading and packing shed, to the terminal market, and in many cases through the retail stores. A test lot usually consisted of a truckload of potatoes as they came from the field. All operations in connection with harvesting, grading and packing, and transporting to market were the same for the test lots as for other potatoes; except they were handled in such a way that they could be identified through all stages of the marketing process.

A research team, consisting of a shipping point crew and a terminal market crew was formed to collect the necessary information. The shipping point crew attempted to obtain a record of the condition of each test lot of potatoes shipped and the factors producing those conditions. The terminal market crew re-

corded the condition of the potatoes when they arrived at the terminal market and what happened to them in the selling process.

To supply information on the causes of damages that occurred during digging, picking up, hauling to the packing shed, grading and packing, and transporting to the market, records were obtained on production practices prior to time of digging, and on how certain operations such as digging, picking up, and transporting to the grading shed were performed. Records were also obtained on time of arrival and method of handling potatoes at the grading shed prior to grading and during the grading and packing operation and on weather conditions such as temperature, relative humidity, wind velocity, and rate of evaporation.

A series of 25-pound samples of potatoes were collected from each test lot at various stages in the marketing process to measure the extent of damage occurring. The first samples were collected from the field containers just prior to loading the potatoes on trucks to be hauled to the packing shed. The second samples were collected just as the potatoes started through the grading and packing process. The third samples were collected after the potatoes had been run through the grading and packing process but just before they were put in bags. One bag in each test lot was marked for special inspection at the terminal market.

The samples were examined by a representative of the Bureau of Plant Industry, and were inspected carefully for such defects as cuts and bruises, insect damage, blights, rots, etc. The inspector also estimated percent of total skin removed from the potatoes of each lot and



recorded any miscellaneous information about it. Samples collected at the shipping point were examined the day they were collected and reexamined at the end of a 3-day period to determine developments of defects that were not apparent at the first examination. The special bag included in each test lot was examined when the potatoes reached the terminal market. This examination was made by representatives of the Bureau of Plant Industry in New York and Chicago. In cases where test cars were sent or directed to markets other than these, the Railroad Perishable Inspection Agency or the Western Weighing and Inspection Bureau inspectors made an examination of the car and the specially marked bag in each lot. The terminal market inspection was the same as the shipping point inspection with two exceptions. Instead of examining the entire bag on arrival and holding the potatoes for a second examination, one-half of the potatoes were examined on arrival and the rest were held for a period of 5 days before they were examined. In the case of the test lots that did not go to New York or Chicago only the initial examination was made. From these series of samples and examinations, it is possible to trace what changes occurred in the test lots of potatoes during the various stages of the marketing process.

### RESULTS

The data collected in 1948 are now in the process of being analyzed. The results presented in this paper are limited to the test shipments sent from Florida because the data from the other States are not ready for release.

The 1948 potato season in Florida was characterized by very unfavorable weather at the time of planting and the

early part of the growing season in both Dade County and the Hastings area. This unfavorable weather was followed by favorable weather during the remainder of the growing season and unusually favorable weather during the harvesting period. Production on the acreage that was harvested was normal or better and quality was good. The demand for the crop was strong during most of the shipping period. Losses from spoilage and other factors was less than normal.

Seventy-four test lots were sent out from Dade County and 61 lots from the Hastings area. All of the lots from Dade County were of the red variety, 58 percent being Bed Bliss and 42 percent Pontiac. In the Hastings area, two lots were Pontiac and the rest Sebago. Results from these shipments must be considered preliminary. In some instances they are contrary to what is commonly believed to be the situation. The findings must be substantiated or disproved by information for another year. However, the data reveal some important differences between Dade County and the Hastings area and indicate some of the factors associated with losses. The main differences in the results of the two areas were in the amount of skinning, cuts and bruises, bacterial soft rot, browning, and scald spots.

Growers in Dade County did an excellent job of handling their potatoes from the standpoint of skinning. Inspection of the test lots indicated that only 3 percent of the total skin was removed in the entire handling process. This compared to 34 percent in the Hastings area with individual lots going as high as 75 percent. Factors affecting skinning were maturity, defoliation, and method of handling. Potatoes in Dade

County averaged 10 days older than those in the Hastings area and 58 percent of the samples were defoliated before they were dug. Defoliation was not practiced by any growers in the Hastings area. In both areas, skinning decreased as the age of the potatoes increased. In the Hastings area skinning amounted to 42 percent for the potatoes less than 93 days old compared to 22 percent for potatoes more than 100 days old. In Dade County skinning dropped from 4.1 percent for potatoes less than 105 days old to 1.7 percent for potatoes 110 days or older. This difference probably would have been greater in Dade County except for the fact that all but two of the lots in the lower age group were defoliated before they were dug.

Red Bliss and Pontiac varieties are more susceptible to cuts and bruises than the Sebago variety. Therefore, cuts and bruises were greater in Dade County than in the Hastings area. In samples taken just after the potatoes were dumped on the washing and grading machine, 14 percent of the potatoes by weight showed cuts and bruises in the Red Bliss variety, 10 percent in Pontiacs and only 4 percent in Sebago. Cuts and bruises decreased with maturity, in Red Bliss declining from 18 to 12 percent as average age went from 101 to 115 days. In the case of these samples, neither the Pontiac nor the Sebago variety showed more cuts and bruises in the low age group than in the high age group.

In 1948, bacterial soft rot was found in 59 percent of the test lots sent out from Dade County when they reached the terminal market in contrast to only 23 percent for the Hastings area. Soft rot amounted to 1 percent or more in 46 percent of the lots from Dade County but in only 6 percent of the cases did it

amount to this much from the Hastings area. The amount of soft rot was closely associated with cuts and bruises. As indicated above, test lots from Dade County contained more cut and bruised potatoes than test lots from the Hastings area. In Dade County, the cuts also tended to be deeper which made it more difficult to dry them out after the potatoes were washed. In the Red Bliss variety, 71 percent of the test lots inspected at the terminal market showed more than 1 percent soft rot in comparison with only 27 percent for the Pontiac variety. In many cases, the inspector stated that soft rot started in deep cuts.

Although the test lots sent out from the Hastings area did not show much soft rot on inspection at the terminal market, 64 percent contained potatoes that developed soft rot around the lenticels. These areas usually dried out before the potatoes reached the market and the soft rot stopped. In many cases this resulted in dark sunken areas around the lenticels that gave the potatoes an unattractive appearance. In severe cases, this seriously affected their sales value and at times was the cause of rejection by the buyer. Improper operation of the drying equipment increased the severity of this condition. Potatoes that were thoroughly dried when they went through the drying equipment developed this condition to a much less extent than those that came out of the machine damp or wet.

Browning was much more severe in the test lots from the Hastings area than it was in lots from Dade County. Only about 4 percent of the potatoes from Dade County showed browning upon arrival at the terminal market. This amount increased to about 6 percent when the potatoes were held for 5 days.

Ten percent of the potatoes from the Hastings area showed browning when they reached the terminal market. At the end of the 5-day holding period, this amount had increased until about 42 percent of the potatoes were affected. Browning, while it does not usually cause spoilage, reduces the demand for the potato as far as the housewife is concerned.

Browning was associated with variety and amount of skinning and in some cases age. In the Sebago variety, every lot showed browning at the end of the 5-day holding period. Only 43 percent of the Red Bliss variety showed browning at the end of the 5-day holding period as compared to 66 percent for the Pontiac variety.

Browning was also milder in the Red Bliss, averaging less than 1 percent of the potatoes as compared to 9 percent for Pontiac. The amount of browning increased as the amount of skinning increased. In the Hastings area, browning averaged 8.6 pounds per 25-pound sample for the group with the least skinning as compared to 12.1 pounds for the group with the highest skinning. The same relation existed for Pontiac with browning being more than twice as much in the group with high skinning as compared with the group with low skinning. In the Pontiac variety browning was much higher in the low age group as compared to the more mature potatoes.

In the Sebago variety there was no relation between age and the amount of browning in the 1948 results.

#### CONCLUSIONS

In 1948, income from potatoes in Florida was reduced by at least 70 thousand dollars as a result of adjustments necessary because of the condition of the potatoes when they reached the terminal market. Most of the adjustments were due to spoilage, resulting from various factors but some were due to poor appearance and shrinkage resulting from shipping very immature potatoes. All of this loss cannot be eliminated but it can be reduced by more careful handling and preparation of the produce for market. Some improvements can be made in the handling of the potatoes in both of the areas studied. It appears that practices followed by growers and shippers in Dade County are better than those found in the Hastings area at the present time. Too often in the latter area, too much emphasis is placed on getting volume through the packing house even though this results in practices that reduce quality and increase losses. Potato growers especially in the Hastings section, LaCrosse area and west Florida are faced with increasing competition from other competing areas. If they are to meet this competition, it becomes increasingly important that they produce, harvest, and pack a superior product.

## STRAWBERRY PRODUCTION IN CENTRAL FLORIDA

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Strawberry is an annual crop in Florida. Each spring, January to April,

plants are secured from the North mainly Arkansas, the Eastern Shore of Maryland and Delaware. These plants are set out on beds and allowed to make runner plants which are removed to other beds during June and July to make still other

runner plants which are set in the fields during the period September 15th to November 1st. Plants bear fruit sometimes as early as late November but usually during December, January, February, March, and April. The shipping season ends April 1-15, and the plants are then plowed up.

Strawberry culture started in central Florida sometime during the 1880's. Several varieties were grown on commercial scale, the Neunan, Cloud, Lady Thompson, and Wilson, but the Neunan appears to have been the choice of most growers. This variety must have possessed "what it takes" for shipment to Northern markets or at least it was fed sufficient potash and picked quite green so that it could be shipped to New York in 32-quart open crates without refrigeration in the ordinary express cars. Quality of fruit probably was not necessary as a selling point. The mere fact that it was shipped during the early months of the year probably sold it because strawberries were a rarity at that season of the year.

The Klondike variety replaced the above-mentioned sometime shortly after the turn of the century. This variety was more productive and of better quality but was still not quite early enough for central Florida and it was fairly susceptible to leaf spot diseases.

A new variety called Missionary was introduced in Virginia in 1906 by a Mr. Nathaniel Gohn who had found it as a chance seedling near Deep Creek, Norfolk County, Virginia. Around 1910 or 1912 the strawberry growers of central Florida started testing this new variety which proved to be better adapted to central Florida conditions than Klondike. Within a few years Missionary completely replaced Klondike as the

commercial variety in central Florida.

Missionary was a success because of the following characteristics: The plant was vigorous and withstood the hot, wet, summer weather. During that period of the year it produced runner plants in abundance to be used in setting the fruiting fields during late summer and early fall. It was an early fruiter, producing fruit under the short-day periods of late November, December, and January, when prices on the Northern market were highest. Most of the other commercial varieties of strawberry would not fruit under a short-day period. The yield of fruit was reasonably high and the quality fairly good, in fact much better than that of varieties previously used. Furthermore, it was so resistant to the common leaf spot diseases that fungicidal spraying was unnecessary during the fruiting season. Missionary has remained the commercial variety, but during the past 10 years it has received such careless treatment in the nurseries that what is now passed on as Missionary has lost many of the desirable characteristics of the original. Plant vigor, yield of fruit, and disease resistance are all low in most of the plants now sold as Missionary.

For years the results of tests of other varieties and new hybrids against Missionary showed that no commercial variety equalled Missionary and of the hybrids only those of Missionary parentage showed any signs of promise. At the present time Missionary is being widely used by plant breeders of the Southeastern States in producing new varieties of strawberries. Some of these new varieties surpass the present day Missionary both in plant vigor and in yield of fruit. There is still room for improvement in type and quality of fruit in these varie-

ties. Klonmore, a Blakemore-Klondike cross, developed by the Louisiana Experiment Station has been the most outstanding of these new varieties.

During the present year strawberry seed which resulted from both self-pollination and cross-pollination between Missionary and Klonmore were saved during March. These seed were planted in flats in the greenhouse at the Strawberry Laboratory and the resultant plants set out in nursery beds. About 7,000 of these seedling plants and their runner plants have been set out on fruiting beds this fall to test their fruiting characteristics.

In this work it was expected that some of the seed might produce plants of wild species of strawberry. At least it was hoped that such might be the case. In this way it might be possible to learn something about the ancestry of the Missionary variety which itself was a chance seedling of unknown parentage. Of the several thousand seed planted, one did produce a plant of wild species, identified as Indian-strawberry or Snake-berry, *Duchesnea indica*.

Since the writer was familiar with the habits of this species he had it set out in a cleared area under an Australian pine. The plant was set the latter part of June and at the present time, October 22nd, has produced so many runner plants that it fills an area 8 feet in diameter. During July these plants started putting on their yellow-petalled flowers and small, spongy, prominently seeded red fruit. This process of blooming and fruiting has been continuous to the present. Evidently this wild parent of the Missionary variety has passed on to the latter its ability to produce runner plants in great abundance during summer weather and perhaps also some resistance to leaf spot

diseases. Its habit of continuous fruit production might make the Indian-strawberry a desirable species to use in producing everbearing varieties of strawberry.

For several years there has been a feeling amongst the strawberry growers that the yield of fruit per acre from Missionary is steadily decreasing. This has been found to be true but there are also factors other than variety involved in this decrease in yield. Weather has always been a factor, with some seasons of extremes, too hot or too cold, too dry or too wet. But a more important factor has been excess drainage, caused by a multiplicity of large drainage ditches together with the necessary highway ditches. This has resulted in a general lowering of the water table in most of the older established fields so that at the present time some method for irrigating has become a necessity.

Even with irrigation, however, the results obtained are not so good as were obtained when the water tables were at a higher and more constant level. Another factor in decreasing yields is the change in method of setting plants. Years ago the two-row bed was used almost exclusively but today most growers have changed to the one-row bed. This was brought about by the scarcity and high cost of labor. The one-row bed can be cultivated mostly by machine and requires but little hand-hoeing, whereas the opposite is true of the two-row bed. However, an acre set out according to the two-row bed plan will contain about 60 percent more plants than an acre in single-row beds, and yields of fruit will be in about the same ratio.

After fruit is produced it must be marketed and at the present time successful

marketing is becoming more and more of a problem. There was a time years ago when Florida strawberries appearing on Northern markets met with practically no competition but such is now a thing of the past. The greatest competition at the present time is the quick-freeze pack of strawberries. The housewife can secure the latter any time during the year and will prefer it to fresh fruit unless the fresh fruit is of exceptionally good quality. This means that the quality of Florida strawberries must be maintained at a high level, by use of good varieties, proper fertilization, and attractive and high quality packaging.

Under the present method of packaging and marketing, the retail buyer of Florida strawberries has no guide to go by. The pint container has no identifying marks as to place of origin or quality.

Each separate purchase is more or less of a gamble. It is the practice for each strawberry grower to have his fruit packed in pint containers in field packing sheds. This results in quite a diversity of type and quality of pack for the area as a whole. It might be better if central packing plants could be used. Picking of fruit in the field would be closely supervised and the picked fruit hauled into the central packing plant. There it would be washed in cold water to remove sand and some heat. The fruit would be dried, graded, and a uniform quality packed. The pint container could be attractively branded and the top covered with a suitable transparent film. Thus the retail buyer of Florida strawberries would have some guide to go by and repeat purchases might become more numerous.

## SWEET CORN GROWING

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Sweet or green corn is fast becoming a major crop in the central Florida section, replacing the growing of roasting ears and field corn. This increase in interest in this crop is largely, if not entirely, due to the development of the new hybrid sweet corns adaptable to our climate. This past season close to 2,500 acres were planted in the Sanford, Winter Garden, and Zellwood sections. Shipments totaled 212 carloads by rail from this section out of a total of 338 carloads by rail from the State, plus an unknown number of truck loads. The truck movement of green corn was larger than the rail freight movement, as a total of 662

carloads of corn left the State by truck. As no records are available as to the point of origin of truck shipments we have no way of determining how many of these truck loads originated in the central Florida section. Present indications are that the acreage in this area will be materially increased this coming season because of the good returns on last season's crop.

In the Sanford area some of the corn is planted after an early crop of celery, cabbage, or other early vegetable. Most of the planting is done in late February or early March, which removes the crop in time to put in a summer cover crop. Heaviest movement was during the period May 2-15.

In the Sanford area it is planted in 30-inch rows with the corn 12-15 inches

apart in the row. In the muck area at Zellwood it is planted in 34-36 inch rows with plants 14-15 inches apart in the row. Fertilizer practices vary greatly depending in large measure on what crop the corn follows. If it follows celery, fertilizer applications are light. Planted on previously unfertilized or lightly fertilized soil, about 2,000 pounds per acre are used, generally in split applications of 1,000 pounds each; one application made at planting time and the second when the corn is about knee high. Usually a 4-5-7 or 4-7-5 fertilizer is used.

Sometimes an additional application of nitrate of soda is made, depending on the rainfall and general appearance of the crop. On the muck, fertilizer applications also vary considerably, as well as the formulas used. The amounts vary from about 750 pounds per acre to 1,500 pounds per acre and the formulas used from 0-8-24 to 5-6-10. Cultivation is confined to what is necessary to keep down weed growth. This generally means two or three cultivations until the corn begins to tassel. After that time it shades the ground enough to keep weed growth down. In addition to the cultivation we generally hoe the corn twice, once when we chop it to stand and a second time at the time of the second cultivation. By keeping down the weed growth the corn gets the full benefit of the fertilizer instead of sharing it with the weeds. We have not tried any of the weed-killing sprays.

The variety most generally grown in both the Sanford and Zellwood area is Ioana. In the Zellwood area considerable Golden Cross Bantam is also grown. Yields, of course, also vary greatly. In the Zellwood area yields varied this past season from around 550 dozen to 900

dozen ears per acre. In the Sanford area 1,000 dozen ears per acre is considered a good yield, with a good many plantings averaging less than this figure. Much of the corn from this area was shipped in bags holding 4-5 dozen ears, while in the Zellwood area most of it was shipped in crates holding 5 dozen or more, depending on size of the ears. In our experimental plantings we had yields as high as 1,857 dozen ears per acre or an average of 39.8 ears per 25-plant plots. It must be borne in mind that this is total yield, not marketable yield. Worm damage would reduce this somewhat, depending on the variety and the efficiency of control measures.

So far we have not had any fungus diseases that attacked corn, so no spraying or dusting with fungicides has been necessary. We do, however, have the fall armyworm or budworm and the corn earworm. For budworm or fall armyworm control we have found spraying much more effective than dusting. Spraying with DDT, 1 quart of 25 percent emulsifiable in 100 gallons of water, as soon as injury is noticed has given satisfactory control. A second application may be necessary if reinfestation takes place. In experiments covering several years we have found that we get better control of the corn earworm with dusting than by spraying. Five percent DDT dust applied every 3 days, beginning when the first silks appear and continuing until the last silks have wilted, which usually means four or five applications of dust, will give good control. It will not eliminate all worm damage, but we have gotten as high as 97 percent marketable ears using this treatment. By marketable ears we mean ears where the worm damage goes no further than 1 inch from the tip of the ear. In the

Zellwood area this past season they obtained good control of the corn earworm through airplane dusting. Frankly, from our experience we believe that airplane dusting will not give adequate control when you have a normal worm population, and certainly not when the infestation is heavy.

In our experimental plantings this past season Oto, Hybrid 57, Hybrid 54, and Erie all outyielded Ioana and Golden Cross Bantam, and in addition they had much tighter husks than Ioana and showed less worm damage. In trials at Gainesville this past season Hybrid 57 had the largest number of marketable ears, Erie second largest, Hybrid 54 third largest, and Oto sixth largest. All of these varieties are characterized by having a very small cob, in fact some of the Hybrid 57 had such a small cob that it might be discounted on that account. All of these varieties with us had a lighter yellow color than Ioana. Erie had the deepest color, almost as deep as Ioana. Hybrid 54 and 57 and Oto had a light yellow color. In ear length all of the above averaged between 8-9 inches, while most of the Ioana varieties averaged between 7-8 inches. Hybrid 57 had 12-14 rows of kernels per ear, Erie 12-16 rows, Hybrid 54 12-14, and Oto 10-12 rows. Hybrid 54 had the smallest kernels, while Oto had the largest. We are ready to recommend that growers make trial plantings of any or all of the above.

One thing is certain, if we are going to increase our acreage in sweet corn

we shall have to pay more and more attention to the quality of our product or we will not be able to dispose of it at a profit. One important step in this direction would be greater care in handling the corn after it is pulled. It is a well known fact that sweet corn rapidly deteriorates in quality after pulling unless it is cooled rapidly. Many growers at the present time pull the corn and pack in bags in the field and let it stay in the field for several hours before it is hauled to the car. You cannot deliver a first quality corn by following this procedure. It should be pulled and hauled to a packing shed where it is immediately cooled and kept cooled until it reaches the market. Greater care must also be exercised in throwing out wormy ears.

While we have no data to back up this suggestion I believe that the big future for our sweet corn lies in shucking it before shipment and wrapping it in pliofilm or some similar wrapper. Stretch-wrapped, I believe would make an ideal package, appealing to the eye and to the taste. The saving in freight, and increased price such corn would bring, should more than offset the extra cost involved. Mr. Dickman of Ruskin has experimented for several years in shipping shucked corn in various containers, but I do not believe that he has stretch-wrapped any. If he has I would like to hear what his experience has been in selling such corn. We have wrapped shucked corn two and three ears in a package for local consumption and have never been able to fill the demand for it.



# SWEET CORN PRODUCTION, HANDLING, AND LOADING

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In recent years the commercial green corn industry has been changing rapidly from the old roasting ear field corn to sweet corns of adapted hybrid varieties and in years to come this crop will occupy a prominent place among other truck crops in the principal vegetable farming areas of our State. Dozens of new varieties of sweet corn have been brought into existence and new ones are coming in each year. Some of the hybrid sweet corns now being grown will be replaced with newer and better ones.

Growers are learning better methods of producing sweet corn. Excellent worm control programs have been found and are being used by some growers. More efficient methods of packing, pre-cooling, and loading for transportation to market are being followed in a number of producing areas. A larger number of markets are being found for good packaged, worm-free corn and more people are eating sweet corn. There remains, however, a great amount of work necessary to get a larger number of growers to produce better yields of good quality corn, as well as improvement in packing and precooling by growers and packers who have not been following the best practices.

In a well-planned and detailed study of sweet corn growing, harvesting, packing, precooling, and loading in cars for

transportation to market, in a number of the principal producing areas in six Southeastern States during the past spring and summer by four Seaboard Air Line Railroad agricultural agents, the writer being included, we found, as expected, that by far entirely too many growers were securing yields that were much too low. Information contained in this study was secured from experiences of farmers, experiment stations, and marketing organizations. Sweet corn growing on some of the best lands in areas visited produced yields of 75 crates or less per acre, whereas if better practices of leguminous cover crop planting, crop rotation, better fertilizing programs followed, better worm control program started at proper time and continued until harvest, yields of corn could easily have been increased to 100 crates or more per acre.

Numbers of sweet corn growers visited were found not following any worm control practices at all, others used practices that were inadequate and inefficient. In the matter of precooling some methods used were rather crude and all of the field heat was not removed soon enough after harvesting and packing before precooling and loading in iced cars.

In Florida sweet corn is grown principally in spring and early summer; however, in recent years there has been some interest in the growing of this crop in fall and winter in the warmer areas of south Florida. Planting for the fall and winter crop extend from latter part of August through October, with spring plantings from latter part of December

through March 15th on muck and vegetable soils. In upper Florida plantings should be made as soon as weather permits.

Sweet corn is grown on muck land under water control, irrigated and non-irrigated sandy loam soils commonly used in vegetable production, and good general farm lands adapted to corn growing. Select well-drained properly conditioned soils. On lands other than muck, corn should follow a leguminous cover crop. Regardless of soil type used, a well prepared seed bed is necessary. On muck and other vegetable soils, spring and early summer corn may be planted after a fall and early winter truck crop has been harvested.

Land should be plowed and disced sufficiently well in advance of planting to allow for decomposition of cover crop. Clean cultivated irrigated lands may be prepared just prior to seeding—a well prepared seed bed is a MUST. On muck and other vegetable crop lands, rows are spaced from 36 to 42 inches in width and on general farm lands 36 to 48 inches. Eight to ten pounds of seed are planted per acre, with plants spaced 12 to 14 inches in drill. Corn is planted in furrow of medium depth and frequent, shallow, clean cultivation should be followed, keeping weeds and grass under control. In cool, wet weather treat seed with a well recommended material (provided seed has not been previously treated) to assure good germination.

Some of the leading varieties recommended for planting in Florida are: Ioana, Golden Cross, Illinois Golden No. 10, U.S. 34, Caramel Cross and Seneca Chief for muck and vegetable lands; Ioana, Golden Cross, Caramelcross, Aristogold No. 1 on general farm lands. Ioana, Golden Cross, Caramelcross, Ari-

stogold No. 1 mature in approximately 80 days, Illinois Golden No. 10 and U.S. 34 90 days, and Seneca Chief less than 70.

Among the best fertilization practices followed are: *Muck Lands*—1,000 pounds of 2-8-10 (N.P.K.) fertilizer applied before or at planting time, plus necessary minor elements, and two applications of a good side dresser of 100 pounds each when corn is 6 to 10 inches high, and second at 12 to 15 inches high. *Other Vegetable Soils*—1,200 to 1,500 pounds of a 4-7-5 or 4-8-6 (N.P.K.) mixture applied before planting and 300 pounds of side dresser (two applications of 150 pounds each when corn is 6 to 8 inches high, and 150 pounds at time corn is 12 to 15 inches high.) *General Farm Land*—800 to 1,200 pounds of a 4-8-6 (N.P.K.) analysis applied before planting, with 300 to 500 pounds of side dresser in two applications before the corn is 15 inches high.

Early plantings will not require as many applications for worm control as midseason or late plantings. For budworms dust at very first sign of worms, making two applications, using 5 percent DDT. Make first dusting of 5 to 7 percent DDT for earworms when first silks appear and dust every other day throughout silking stage, requiring 6 to 8 applications, based on two corn pickings. More than two pickings will require additional dust applications. With hand, horse-drawn or tractor-dusting equipment from 15 to 25 pounds is required per acre application. Dusting with aeroplane requires 40 pounds per-acre applications. While DDT has been used with good results, there is no definite information available as to the residual effect this material may have on the soil.

Harvesting should begin when the ears

are well filled out, but still in the milk stage. Time is the essence of success. Corn must be harvested at proper maturity, moved from field to packing locations in convenient containers or vehicles, graded, packed, precooled, and placed under ice in as short a time as possible. Sugar in the corn turns to starch within 4 hours if field heat is not immediately removed.

Packing should be done under cover where precooling is available. Worm-free corn should be packed in crates, as crated corn brings a higher return to the grower. Worm-infested corn should be clipped and packed in bags.

Corn grown on good land under favorable conditions will produce 500 dozen ears, or 100 crates, per acre. Muck or irrigated lands yield up to 200 crates per acre.

Mechanical precoolers, where the temperature of the water is kept about 34

degrees and container remains in the bath approximately 22 minutes, or ice water spray precooling machines in which the corn remains for 14 to 22 minutes (depending on speed of conveyor) with water temperature of 38 to 40 degrees, are used with good results. Where mechanical precoolers are not available, a wooden or metal vat, 4 feet wide, 30 to 60 feet long, using snow or cracked ice in the water and in which corn remains in the bath for at least 15 minutes, are generally satisfactory. Corn should move direct from precooler to refrigerated cars.

Sweet corn should be shipped under standard refrigeration using 7 tons of top ice (snow ice recommended) when properly precooled. When packed in crates top ice after car is loaded. When packed in sacks snow ice should be applied between every second layer of corn.

# PROCESSING SECTION



# STANDARDIZATION OF CANNED CITRUS JUICE BY THE USE OF PARTIAL CONCENTRATION<sup>1</sup>

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The object of the work to be reported on this afternoon was to find out if a low-solids and low-acid orange juice could be improved in quality by concentration. The term "standardization" as used here will refer to the partial concentration of orange juice to raise the Brix and acid to minimums of 10.5 degrees and 0.75 percent, respectively. It is possible that if internal grades for fresh fruit are raised, standardization of canned citrus juices by partial concentration may offer a possible use for some fruit with solids content under that required for fresh fruit.

Three experimental packs, consisting of a control and two partially concentrated juices, were put up in plain tin cans and stored at 40° and 80°F., and examined initially, and at the end of 3 and 6 months. After storage for 3 months at 80°F., samples of the three juices were sent to all Florida citrus processors for taste comparisons. The

results of these taste tests indicated that the quality of the orange juice had been improved by partial concentration.

## EXPERIMENTAL

*Procedure.* The oranges used in this work were Hamlins obtained from certain experimental plots at the Citrus Experiment Station, Lake Alfred, Florida. These grove-run oranges were specially chosen for their low-solids content in an effort to show what could be done to standardize as poor a sample as is likely to be encountered in a canning operation. The fruit was washed at the Citrus Experiment Station and then trucked in field boxes to the U. S. Citrus Products Station, Winter Haven, Florida, where it was held at about 40°F. for 4 days before processing on December 31, 1946.

The juice was extracted using a rotary juice press, passed through a 0.030 inch screen, and held in a stainless steel holding tank until the quantity of juice needed for the packs had been collected. The juice was then processed further as follows:

*Control pack.* A quantity of deaerated juice was used for the control pack.

*Concentrate-added pack.* A quantity of the juice was concentrated under vacuum to 55 degrees Brix at a temperature of 90°F. This 55 degrees Brix concentrate was then added to a quantity of deaerated juice to adjust the Brix to at least 10.5 degrees. Table 1, calculated from sucrose values (1), gives the gallons of 55 degrees Brix solution to add to 100 gallons of a given low-Brix solu-

<sup>1</sup> Paper prepared by Edwin L. Moore and delivered by C. D. Atkins at the 61st Annual Meeting of the Florida State Horticultural Society, West Palm Beach, Florida, October 28, 1948. This paper is condensed from a previously published article titled, "An Experiment on Partial Concentration As a Means of Standardizing Low-Solids Orange Juice," by Edwin L. Moore, L. G. MacDowell, C. D. Atkins, and Richard L. Huggart, that appeared in *Fruit Products Journal*, Vol. 27, pp. 72-74 (November 1947), and is reprinted with the permission of *Fruit Products Journal*.

TABLE 1

GALLONS OF 55° BRIX SOLUTION TO ADD TO  
100 GALLONS OF A GIVEN LOW-BRIX SOLUTION  
TO OBTAIN A 10.5° BRIX SOLUTION  
(BASED ON SUCROSE VALUES)

<div> GIVEN BRIX </div> <div> DESIRED BRIX </div>	7.0	7.5	8.0	8.5	9.0	9.5	10.0
10.5	6.4	5.5	4.6	3.7	2.8	1.9	0.9

TABLE 2

GALLONS OF WATER TO EVAPORATE FROM  
100 GALLONS OF A GIVEN LOW-BRIX SOLUTION TO  
OBTAIN 10.5° AND 55° BRIX SOLUTIONS  
(BASED ON SUCROSE VALUES)

<div> GIVEN BRIX </div> <div> DESIRED BRIX </div>	7.0	7.5	8.0	8.5	9.0	9.5	10.0
10.5	34.3	29.4	24.6	19.7	14.8	9.9	4.9
55	89.6	88.9	88.1	87.3	86.5	85.8	85.0

tion to obtain a 10.5 degrees Brix solution, and may be used as an approximation for citrus juices.

**Concentrated pack.** The remainder of the juice was concentrated under vacuum to at least 10.5 degrees Brix at a temperature of 90°F. Table, 2, calculated from sucrose values (1), gives the gallons of water to evaporate from 100 gallons of a given low-Brix solution to obtain 10.5 degrees and 55 degrees Brix solutions.

The "control," "Concentrate-added," and "Concentrated" juices were pasteurized at 200°-205°F., filled at 190°-195°F. into 9½ fluid ounce cans (1.25 hot-dip tin plate), sealed, and cooled. In general, the canned juices showed a 9- to 10-inch vacuum and a gross headspace of 3/16 to 4/16 inch.

Each of the three packs consisted of approximately 10 cases of 24 cans each, and a part of each pack was placed in storage at 40° and 80°F.

**Results.** The initial analysis of the juice packs for Brix, total acid, and ascorbic acid, is given in Table 3. It

will be noted that the "Control" juice is low in Brix (7.43 degrees) and acid (0.55 percent), and that the "Concentrate-added" and "Concentrated" juices have been standardized to at least 10.5 degrees Brix and 0.75 percent acid. Also, the high ascorbic acid content of the "Concentrate-added" and "Concentrated" juices will be noted.

All three juices stored at 40°F. for 6 months retained about 97 percent of their initial ascorbic acid content. During storage at 80°F. for the same period of time, all juices retained about 88 percent of their initial ascorbic acid content with no significant differences between the packs.

After storage for 3 months at 80°F., coded samples of the three juices, with some descriptive information, were sent to all Florida citrus processors with the request that the juices be tasted by the members of each organization. A questionnaire was enclosed to be filled out and returned to the Research Department of the Florida Citrus Commission.

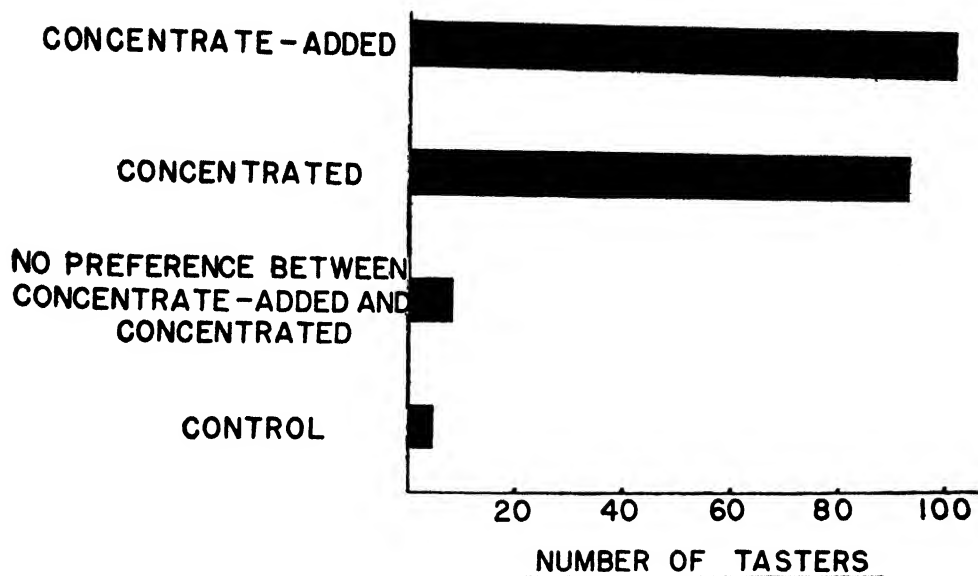
Thirty-nine canners, represented by

TABLE 3

### INITIAL ANALYSIS OF THE CANNED ORANGE JUICES

	CONTROL	CONCENTRATE- ADDED	CONCENTRATED
°BRIX . . . . .	7.43	10.65	10.70
TOTAL ACID, % . . . . .	0.55	0.79	0.78
ASCORBIC ACID, MG./100ML.	39.8	58.4	59.3





**FIGURE I — PREFERENCES OF TASTERS FOR THE CANNED ORANGE JUICES AFTER STORAGE OF JUICES FOR 3 MONTHS AT 80° F.**

210 tasters. generously cooperated in tasting these samples of orange juices and returning the questionnaires. These results are presented graphically in Figure I. Of these 210 tasters, 103 preferred the "Concentrate-added" juice, 94 preferred the "Concentrated" juice, 8 had no preference between the "Concentrate-added" and "Concentrated" as the best juice, and 5 preferred the "Control" juice. From these results on taste tests, it would appear that the quality of the orange juice had been improved by either method of concentration used.

#### SUMMARY

Three experimental packs, consisting of a control and two partially concentrated juices, were put up in plain tin cans and stored at 40° and 80°F. The

packs were analyzed initially and at the end of 3 and 6 months to study partial concentration as a means of standardizing low-solids and low-acid orange juice to improve its quality.

No significant differences in retention of ascorbic acid were found between the packs at the end of the storage periods.

Thirty-nine canners, represented by 210 tasters, cooperated in tasting the packs of juices after the juices had been stored at 80°F. for 3 months. The results of these taste tests indicated that the quality of the orange juice had been improved by partial concentration.

#### REFERENCE

- (1) *Handbook of Chemistry and Physics*. 26th Edition., pp. 1548-1549, (1942) Chemical Rubber Publishing Co., Cleveland, Ohio.

# THE COMPOSITION OF FLORIDA CITRUS MOLASSES<sup>1</sup>

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Citrus molasses is a comparatively new product. Although information has been available on the composition of the press juice from which it is made, little has been published on the composition of the molasses itself. It is the purpose of this paper to present data obtained in chemical analyses of 13 samples of citrus molasses.

Citrus molasses is produced from the waste peel, rag, and seeds from the citrus canneries. The waste is first ground with a hammer mill into pieces about a quarter of an inch in diameter. Lime is added to neutralize the acidity, react with the pectin, and facilitate pressing and drying. The ground peel is passed through a pug mill in which it is kept in constant agitation for about 10 minutes or is placed in bins for 30 to 45 minutes to permit the lime to react. In areas where fuel is cheap the peel may be passed directly to the driers. In Florida where fuel costs are an important factor, as much of the liquid as possible is first removed by pressing and the pulp then passed to steam-heated or direct-fired rotary driers. The removed liquid, or press juice, is concentrated in multiple-effect evaporators, having two, three, or

four effects and sometimes having a finishing pan. The juice has originally a soluble solids content of from 6 to 11 percent, depending on the nature of the fruit and method of handling the peel. For instance, the value will be lower if water has been used in transporting the peel or if a lime slurry has been used instead of dry lime. In the evaporators the soluble solids content is increased to about 73 percent. The temperatures used range from 245° to 135° F. and naturally vary with the type and the number of effects.

Both the dried pulp and molasses are used extensively as feeds. Citrus molasses is also used in the production of alcohol (12). Several studies have been reported on the feeding value and chemical composition of dried citrus pulp (1, 5, 6, 7, 8, 9, 10, 12, 13). Becker, Arnold, Davis, and Fouts (3 and 4) estimated 1.4 percent digestible crude protein and 56.7 percent total digestible nutrients in citrus molasses, based on 69.9 percent dry matter. These authors also reported 3 to 5 percent each of crude protein and ash and the absence of crude fiber. The manufacture of dried pulp and molasses provides a complete answer to the disposal problem of citrus peel in that all the organic matter is retained and converted to useful products.

Table I gives information on the production in Florida of dried citrus feed and molasses. It will be noted that the ratio of citrus molasses to dried pulp has been steadily increasing. In general, the mills have been equipped first for the

<sup>1</sup> Agricultural Chemical Research Division Contribution No. 239.

<sup>2</sup> Superior Council of Scientific Research Institute of Chemistry, "Alonso Barba," Madrid, Spain.

<sup>3</sup> One of the laboratories of the Bureau of Agricultural & Industrial Chemistry, Agricultural Research Administration, U. S. Department of Agriculture.

production of dried pulp and the molasses units have been added later. A few mills still have no evaporators and the press juice is discarded.

#### EXPERIMENTAL

Samples of freshly manufactured citrus molasses were collected at intervals from the early part to well past the middle of the 1947-48 citrus canning season from eight feed and molasses plants in Florida. The samples were transported directly to the laboratory, being placed in a refrigerator at 350° F. within 3 days of manufacture. Portions were drawn from cold storage as needed for analysis, not more than two samples were taken from a single evaporator.

Official methods of analyses (2) were used in the determination of total solids, crude protein ( $N \times 6.25$ ), pectin (alcohol precipitate), ash, total acidity (calculated as citric acid), volatile acidity (calculated as acetic acid), calcium in ash, and magnesium in ash. Total sugars, nonreducing sugars, and reducing sugars were determined by the Munson-Walker gravimetric method and all reported as invert sugars. Overnight acid inversion

was used. pH was determined with a glass electrode; degrees Brix with an Abbe type refractometer and by diluting with an equal weight of water and determining density with a spindle; color by comparison with Maerz and Paul color charts; and viscosity with a Stormer viscosimeter standardized with a Bureau of Standards reference fluid having a viscosity of 1282 centerpoises.

#### RESULTS

The results of the analyses are given in Tables II and III. Samples Nos. 1, 4, 5, 6, 10, 11, and 12 were from plants with quadruple-effect evaporators having finishing pans; samples Nos. 2, 3, 7, 9, and 13 were from plants with triple-effect evaporators; and sample No. 8 was from a plant with a two-stage evaporator in which the first effect was the direct-fired spray type and the second of conventional design. Sample No. 4 was made from orange peel only; all the others were made from a mixture of grapefruit and orange peel.

*Concentration.* The results permit a comparison of the degrees Brix as estimated by the refractometer, spindle, and drying methods.

TABLE I  
PRODUCTION OF DRIED CITRUS PULP AND CITRUS MOLASSES IN FLORIDA

<i>Season</i>	<i>Dried Citrus Pulp</i>	<i>Citrus Molasses</i>
1940-41	32,730 tons	0
1941-42	29,696 tons	2,500 <sup>2</sup>
1942-43	47,376 tons	5,700 <sup>2</sup>
1943-44	67,130 tons	14,496 tons
1944-45	68,724 tons	19,260 tons
1945-46	108,470 tons	44,168 tons
1946-47	96,914 tons	55,811 tons
1947-48	154,181 tons <sup>1</sup>	65,887 tons <sup>1</sup>

Data obtained from Citrus Processors Association, Inc., Tampa, Florida.

<sup>1</sup> Tentative.

<sup>2</sup> Data from Office of Supply, War Food Administration.

The refractometer method, the one most generally used, indicated concentrations from 64.44 to 74.52 degrees Brix, with an average value of 71.37. It is believed that the lower values were largely due to the method of sampling in that samples of fresh material were taken and lots were generally blended later to the desired strength.

The spindle method of estimating concentration provides a rapid procedure when a refractometer is not available. The molasses is too thick for a direct reading; so it is diluted with an equal weight of water, the density determined corrections applied, and the result multiplied by two. The average value obtained was 72.28 degrees Brix, about 0.9 degrees higher than by the refractometer method.

In the third method of estimating concentration the samples were dried on pumice stone at 70° C. under vacuum. This method gave values averaging 70.43 percent total solids, or about 1 percent below those obtained with the refractometer. Any of the three methods of estimating concentration is suitable; but it should not be expected that identical values be obtained.

**Sugars.** The values for total sugars, reducing sugars, and nonreducing sugars show some variations, but these are to be expected with this type of product. The sugars averaged 59.8 percent of the total solids and ranged from 47.8 to 65.4 percent. With 9 of the 13 samples the percentage of sugars in the total solids was within the range of 55 to 65 percent. To obtain information on changes in sugars during concentration, 25 gallons of press juice were brought to the laboratory and concentrated under atmospheric conditions in a steam-jacketed kettle. Before concentration the Brix was 9.3

degrees, the reducing sugars 2.94 percent, and the total sugars 5.64 percent. After concentration the corresponding values were 73.86 degrees, 23.74 percent, and .44.55 percent, respectively. Since the ratios of these constituents were nearly the same after concentration as before, it was concluded that the sugars change very little during the process. It is believed that the conditions in the laboratory were as severe as those encountered in commercial plants.

**Protein.** The crude protein values ranged from 3.35 to 4.15 percent. While the amount present is significant, molasses must be classed as a low protein material.

**Pectin.** Pectin determinations by the alcohol precipitation method gave values ranging from 0.80 to 1.59 percent. These quantities of pectin probably contribute materially to the viscosity of the molasses. An effort was made to determine pectin acid by the official method but light-colored precipitates were never obtained and the values are not reported.

**Acidity.** Total acidity and pH are under the control of the operator by varying the amount of lime added. It is evident that most of the original acidity in the waste peel and pulp had been neutralized. The volatile acidity, as expected, was reduced to very low values by the concentration process.

**Ash.** The ash is due largely to the addition of lime to the peel and this is reflected in the high calcium values. Some magnesium was also found. Both of these elements are of value in the compounding of feeds.

**Color.** Most of the samples were quite dark in color, being brown to dark brown. Three of the samples, however, Nos. 3, 7, and 13, were lighter. The

TABLE II  
COMPOSITION OF CITRUS MOLASSES

Sample No.	1	2	3	4	5	6	7	8	9	10	11	12	13	Ave.
Made	10/21/ 47	11/13/ 47	11/24/ 47	11/25/ 47	12/15/ 47	12/18/ 47	12/18/ 47	1/30/ 48	2/24/ 48	2/24/ 48	2/25/ 48	2/26/ 48	2/27/ 48	
° Brix (refr.)	71.64	71.48	64.44	70.98	71.42	72.72	69.34	72.02	71.46	71.89	71.45	74.40	74.52	71.37
° Brix (spindle)	70.46	73.02	64.25	73.41	72.24	73.72	70.04	72.09	73.46	73.55	72.99	75.52	74.94	72.28
Total	71.05	70.04	63.85	70.05	69.25	70.90	68.80	71.57	70.78	70.69	70.75	73.66	74.14	70.43
Volatile														
Matter %	28.95	29.96	36.15	29.95	30.75	29.10	31.20	28.43	29.22	29.31	29.25	26.34	25.86	29.57
Total	46.50	41.58	39.60	44.68	33.10	46.56	44.83	38.52	42.77	41.04	37.45	42.13	46.06	42.09
Reducing														
Sugar %	19.66	19.46	20.49	22.66	16.88	23.62	24.98	25.85	25.87	23.65	22.71	21.83	24.01	22.44
Non-red.														
Sugar %	26.84	22.12	19.11	22.02	16.22	22.94	19.85	12.67	16.90	17.39	14.74	20.30	22.05	19.65
Protein, crude														
% (N x 6.25)	3.93	3.80	3.35 -	3.54	3.85	4.00	3.71	4.14	3.65	3.76	3.70	3.91	4.15	3.81
Pectin %														
(alc. ppt.)	0.91	0.99	1.05	1.19	1.21	1.59	1.25	0.97	0.80	1.08	1.09	0.99	0.80	1.07
pH	5.7	4.5	4.6	3.9	4.1	3.6	4.1	4.1	5.4	5.6	5.7	5.6	4.1	4.68
Total Acidity														
as Citric %	0.56	0.51	0.58	0.94	0.66	0.81	0.74	1.20	0.24	0.26	0.25	0.34	1.19	0.64
Volatile Acidity														
as Acetic %	0.02	0.02	0.04	0.06	0.07	0.09	0.04	0.17	0.02	0.04	0.05	0.02	0.05	0.053
Ash														
%	4.43	5.11	4.23	5.07	5.00	5.25	5.08	5.81	4.51	4.52	4.42	4.05	4.69	4.77

TABLE II—(Continued)  
COMPOSITION OF CITRUS MOLASSES

Sample No.	1	2	3	4	5	6	7	8	9	10	11	12	13	Ave.
Ca in ash %	24.6	30.7	29.5	28.9	33.4	28.4	27.4	34.5	34.1	27.4	28.6	28.2	32.2	29.84
Mg. in ash %	2.4	1.8	2.7	2.2	2.1	2.2	2.3	1.7	2.3	2.0	1.9	2.0	2.2	2.14
Color (M&P)	7-C-12	6-B-12	9-1-5	6-A-12	5-B-12	7-L-12	10-1-6	8-L-6	7-A-12	7-H-12	7-A-12	7-A-12	9-1-8	

TABLE III  
VISCOSITY OF CITRUS MOLASSES  
CENTIPOISES

Sample No.	1	2	3	4	5	6	7	8	9	10	11	12	13
77° F.	892		410		2320	4250	1445		4250			8030	5700
86° F.	606	4800	321	1471	1382	2800	1070	2441	2500	1659	2242	4820	3391
95° F.	446	3120	250	1026	891	1918	750	1480	1640	1160	1460	3210	2140
104° F.	321	2020	205	722	677	1356	553	963	1160	838	1070	2195	1460
113° F.	250	1440	169	538	500	1025	418	748	820	624	767	1532	1019
122° F.	209	1123	148	420	374	787	338	570	624	475	577	1107	748
131° F.	178	829	130	321	294	617	268	428	467	378	445	820	562
140° F.	152	642	121	252	246	467	216	334	357	303	350	625	432
149° F.	134	500	114	214	214	374	189	260	294	253	285	507	330
158° F.	121	407	103	187	182	312	164	214	250	223	243	407	267
167° F.	112	353	98	168	160	271	157	193	223	198	224	342	223
176° F.	107	312	98	183	157	241	150	169	205	187	214	307	196

amount of suspended matter and degree of dispersion may be the principal factors in these differences in color. The small particles of pulp darken very little during the concentration process. The pH and ash values were in the same range and this ruled out the possibility of differences in degree of liming. Samples Nos. 3 and 7 were below the average in concentration, and sample No. 13 above the average.

*Viscosity.* The viscosity values (Table III) are of interest in devising means and equipment for handling the citrus molasses. Values were obtained over the range of 77° to 176° F.; but no values are reported for temperatures lower than 77° F. because the instrument is not well-suited to solutions of the thickness encountered at those temperatures. As would be expected, the viscosity of each sample decreased rapidly with increase in temperature, but there was considerable variation among the samples. Some of this variation was due to the degree of concentration, sample No. 3 being the least concentrated as well as the least viscous. But since different samples of substantially the same concentration also showed substantial variations, probably the condition of the fruit, variety, time of the season, and method of preparation also affected the viscosity.

#### DISCUSSION

In comparing the values obtained with those which Nolte, von Loesecke, and Pulley (12) obtained with citrus press juice, it is noted that the sugars constituted a smaller proportion of the total solids in the citrus molasses examined. The results of Nolte et al indicated 74 percent of the solids in the press juice to be sugar. Recently in connection with investigations on feed yeast, numerous

analyses were made on citrus press juice. Occasionally percentages of 75 percent were obtained; but usually the values ranged from 50 to 70 percent. When the lowest values were encountered it was thought probable that there had been some loss of sugars by fermentation in the peel bins or during storage of the press juice. Protein values of the press juice were about in the same proportion as in the molasses; pectin values were smaller with citrus molasses, possibly because of the adverse effect of the heating during concentration. Fixed acidity was somewhat lower with the molasses, and as would be expected, tests for volatile citrus peel oils in the molasses samples did not reveal detectable quantities by the usual methods.

#### SUMMARY

The chemical analyses of 13 samples of citrus molasses are presented. The average values obtained were: 71.37 degrees Brix by refractometer, 72.28 degrees Brix by spindle; 70.43 percent total solids; 42.09 percent total sugars; 22.44 percent reducing sugars; 19.65 percent nonreducing sugars; 3.81 percent protein; 1.07 percent pectin (alcohol precipitate); pH 4.68; 0.64 percent total acidity as citric acid; 0.053 percent volatile acidity as acetic acid; 4.77 percent ash; 29.84 percent calcium in ash; and 2.14 percent magnesium in ash. Viscosities at temperatures ranging from 77° to 176° F. and Maerz and Paul color values are also given.

The values obtained are in general agreement with those calculated from other data on the composition of citrus press juice from which the molasses is made. The material is high in carbohydrates and contains substantial quantities of crude protein and ash. Calcium

comprises a major portion of the ash. The citrus molasses is similar in composition to blackstrap molasses made from cane and finds similar uses, particularly in the compounding of mixed feeds.

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# PHYSICAL AND CHEMICAL CHARACTERISTICS OF FLORIDIAN COLDPRESSED OIL OF ORANGE (1947-48 SEASON)

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A one-year survey of the commercial production of essential oils in Florida was completed in June 1948, at which time the citrus processing industries were approaching the end of another season. Methods of commercial production, that were used throughout the State during the 1947-48 season, were studied, and the physical and chemical properties of many samples of orange oil were determined. The principal purpose of this investigation was to determine by what means essential oils of very high quality could be produced. Through the use of the data obtained, it is hoped that the citrus industry in Florida will be able to produce citrus oils which will consistently meet the specifications of the United States Pharmacopoeia (4) and also other high quality requirements of the essential oil consumers throughout the country. The production of oils of highest quality and uniformity should result in a larger consumer market.

Another purpose of this study was to determine the relationship between the physical and chemical characteristics of oil of orange and such factors as methods of extraction and methods of processing.

It is realized that the results herein presented are based on the commercial

production of essential oils for only one season. However, representatives of the citrus industry have cooperated readily and have shown keen interest in this work. Therefore, some of the results of this investigation are presented at the present time, since it is believed that they will be of immediate help to those manufacturers who are now producing essential oils in Florida. A similar survey will be continued for one or two additional seasons, and other factors affecting quality will be investigated.

## METHODS OF COMMERCIAL MANUFACTURE

Citrus peel oils are expressed by four different types of equipment; namely, (1) Pipkin Roll, (2) Screw Press, (3) Fraser Brace Extractor, and (4) Pipkin Juice Extractor. The general processing procedure, which is used after the extraction of the oil from the peel, is very similar in most of the commercial plants. All of the above methods of extraction give an emulsion of oil and water. The oil is separated centrifugally from the aqueous phase by passing the emulsion through a sludger (8,000-10,000 r.p.m.) and then through a polisher (16,000-18,000 r.p.m.). Following separation, the oil is stored for approximately one week at 32°-40°F. and during this winterizing treatment undesirable waxy materials separate from the oil and are allowed to settle. The clear oil is decanted into stainless steel storage tanks or tin-dipped containers, which are then maintained at a storage temperature of

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about 40°F. Air is usually excluded from the containers in order to prevent deterioration, and the exclusion of air is usually accomplished either by filling the container full of oil or by displacement of the air with carbon dioxide.

#### EXPERIMENTAL PROCEDURE—SURVEY OF COMMERCIAL PLANTS

Information pertaining to the various processes used in Florida for the manufacture of expressed citrus peel oils was secured through the helpful cooperation of commercial processors. In order to secure the data used in computing yield values, the authors visited plants employing the various methods of oil extraction. Rate of flow measurements were made on each unit process operation for each individual process. Data were taken covering periods of operation of 4 to 24 hours duration.

#### COLLECTION OF SAMPLES

Twenty-five samples of coldpressed oil of orange were secured from four plants, each one of which was using a different method for the extraction of the oil from the peel. These samples were taken once a month from lots of oil ranging from 500 to 11,000 pounds which represented the production for approximately one week.

#### METHODS OF ANALYSES

The physical properties of the original oils and the 10 percent distillates were determined by the Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists (1). The specific gravity was determined at 25°C. and the optical rotation at 25°C. as recommended by the United States Pharmacopoeia (4).

The aldehyde content of the oils was determined by the hydroxylamine method, a standard procedure for which is given by Guenther (2). The final end point for the reaction was obtained by using a titrimeter rather than the bromphenol blue indicator. All of the aldehyde values were calculated as decyl aldehyde.

The method of Seeker and Kirby as reported by Poore (3) was used for the determination of esters. In this method the aldehydes present are removed with hydroxylamine hydrochloride prior to the saponification of the esters.

The evaporation residue was determined by a method very similar to that given by Guenther (2). A watch glass (100 mm. in diameter) was used in place of an evaporating dish, and after having been heated on the steam bath for the prescribed length of time the watch glass was transferred to an oven at 100°C. and dried for one hour.

#### EXPERIMENTAL RESULTS

The physical and chemical properties of samples of coldpressed oil of orange, which were secured from four commercial plants each month from October 1947 through May 1948, are presented in Table 1. Each of the four plants used a different method for expressing the oil.

Data secured at the various processing plants pertaining to the yields of oil obtained by the different methods of extraction are presented in Table 2. Table 2 also shows the relationship between the yields of coldpressed orange oils, which were obtained by the four methods of extraction, and all of the physical and chemical properties of the oils, except the aldehyde content. Data for all four of the different methods of extraction are not available for the months



TABLE 1—(Continued)

Pipkin Juice Extractor	50% P 50% S	0.8430	1.4724	1.4710	0.0014	+96.81	+97.37	0.56	1.78	0.38	2.19
Screw Press	45% P 10% V	0.8420	1.4723	1.4710	0.0013	+97.13	+97.54	0.41	1.41	0.20	1.68
Pipkin roll	50% P 50% S	0.8424	1.4722	1.4709	0.0013	+97.76	+97.77	0.01	1.70	0.15	1.49
March 1948											
Fraser Brace Extractor	50% P 50% S	0.8449	1.4734	1.4710	0.0024	+95.21	+96.96	1.75	1.64	0.35	3.70
Pipkin Juice Extractor	100% V 50% P	0.8428	1.4723	1.4708	0.0015	+96.61	+96.96	0.35	2.04	0.08	2.08
Screw Press	50% P&S	0.8421	1.4719	1.4711	0.0008	+97.04	+97.24	0.20	1.52	0.04	1.95
Pipkin Roll	100% V	0.8420	1.4718	1.4708	0.0010	+97.34	+98.19	0.85	1.98	0.34	1.07
April 1948											
Fraser Brace Extractor	100% V	0.8441	1.4730	1.4713	0.0017	+96.10	+97.61	1.51	1.65	0.97	8.12
Pipkin Juice Extractor	100% V	0.8431	1.4725	1.4712	0.0013	+96.19	+97.21	1.02	1.97	0.53	2.09
Screw Press	100% V	0.8420	1.4722	1.4711	0.0011	+96.69	+97.25	0.56	1.52	0.53	1.71
Pipkin Roll	100% V	0.8423	1.4721	1.4711	0.0010	+97.16	+97.52	0.36	2.02	0.39	1.31
May 1948											
Fraser Brace Extractor	100% V	0.8455	1.4733	1.4713	0.0020	+95.66	+98.10	2.44	1.45	1.50	3.99
Pipkin Juice Extractor	100% V	0.8431	1.4723	1.4710	0.0013	+96.66	+97.83	1.17	1.77	0.91	2.36
Screw Press	100% V	0.8426	1.4721	1.4712	0.0009	+97.59	+98.32	0.73	1.38	0.95	2.11
Pipkin Roll	100% V	0.8425	1.4719	1.4710	0.0009	+97.73	+98.19	0.46	1.72	1.01	1.57

H=Hamlin, PB=Parson Brown, P=Pineapple, S=Seedling, V=Valencia      Coefficient of viscosity.      Proportional to.

prior to February; therefore, they could not be used to secure average values for comparison purposes. The data presented are average values for the three months, March, April, and May, and also were secured during those months when only one variety, Valencia, of oranges was being processed. Figs. 1, 2 and 3 present these results in graphic form.

The relationship between the aldehyde content of expressed oil of orange and the quantity of aqueous phase, which comes in contact with the oil during processing, can be seen from Table 3 and Fig. 4. Here, also, the average values for the aldehyde content of samples of oil secured during March, April, and May are used. The results secured for oils which were extracted during January and February by the Fraser Brace Extractor were not included in these average values because a basic change was made in this processing method after these samples of oil had been obtained. Extremely large quantities of water were being used with this extractor during January and February. In March the amount of water used was reduced to give 100 gallons of an aqueous phase per gallon of oil produced and the oil extracted in that month contained 52 percent more aldehydes than the February sample.

#### DISCUSSION OF RESULTS—RELATION OF YIELD TO PROPERTIES AND U. S. P. SPECIFICATIONS

The factor which was found to influence the physical and chemical properties of coldpressed oil of orange to the greatest extent was the yield of oil secured from the peel. As shown in Table 2 and Figs. 1 and 2, as the yield increased the values for the specific grav-

TABLE 2  
RELATION OF YIELD TO THE CHARACTERISTICS OF FLORIDIAN OIL OF ORANGE

Yield . lb. Oil/Ton Peel	Specific Gravity 25°C./25°C.	Evaporation Residue %	Optical Rotation ° 25 D	Refractive Index ° 20 D	Ester Content %	Method of Extraction
9.70	.8448	3.60	+95.66	1.4732	0.94	Fraser Brace Extractor
7.00	.8430	2.18	+96.49	1.4724	0.51	Pipkin Juice Extractor
4.90	.8422	1.92	+97.11	1.4721	0.51	Screw Press
1.85	.8423	1.32	+97.41	1.4719	0.58	Pipkin Roll

<sup>1</sup> Proportional to. <sup>2</sup> Coefficient of viscosity.

TABLE 3

EFFECT OF QUANTITY OF AQUEOUS PHASE ON THE ALDEHYDE CONTENT OF FLORIDIAN OIL OF ORANGE

Aqueous Phase Gal./Gal. Oil	Aldehyde Content %	Method of Extraction
12.5	1.93	Pipkin Juice Extractor
21.5	1.91	Pipkin Roll
100.0	1.58	Fraser Brace Extractor
190.0	1.47	Screw Press

ity, evaporation residue, and refractive index also increased, but the values for the optical rotation decreased. Thus the percentage of the total amount of oil in the peel that is extracted determines the characteristics of the oil and, therefore, its final quality. As the yield of oil is increased, more high-boiling, high-molecular weight constituents are evidently extracted, and the presence of a greater percentage of these compounds in the oil causes a reduction in the percentage of d-limonene, resulting in lower optical rotation values, since d-limonene is the most optically active component in the oil.

Analyses of expressed oils of orange secured during the 1947-48 season indicate that the oil produced by some of the manufacturing processes at certain times during the season did not meet the U. S. P. (4) specifications, because some of the processes resulted in yields which were too low or too high. Only one method of extraction gave yields throughout the season so that the oil consistently met the requirements of the U. S. P. However, it is apparent that if oil is extracted in such a manner that the yield falls within a certain range, then it will meet U. S. P. specifications. If the

yield is below the minimum of this range, then the values for specific gravity, refractive index, and evaporation residue will be below the U. S. P. requirements, and if the yield is above the maximum of this range, then the differences between the optical rotation and refractive index values of the original oil and the 10 percent distillate will not meet the U. S. P. standards. However, utilization of data obtained during this investigation will make it possible for any processor to produce an oil which will meet U. S. P. specifications, providing that he is willing to change his manufacturing procedures. He may still use available equipment in such a manner that he will secure a yield of oil having these properties which are indicative of good quality. Excessively high or low yields should be decreased or increased by the mode of operation of the extraction equipment. Based upon data accumulated during the past year it is estimated that a yield of 6.5 to 8.5 pounds of oil per ton of peel from midseason oranges or the extraction of 45 to 60 percent of the total amount of oil in the peel of any variety of fruit of good maturity will result in a coldpressed oil of orange that will meet the specifications of the United States Pharmacopoeia (4).

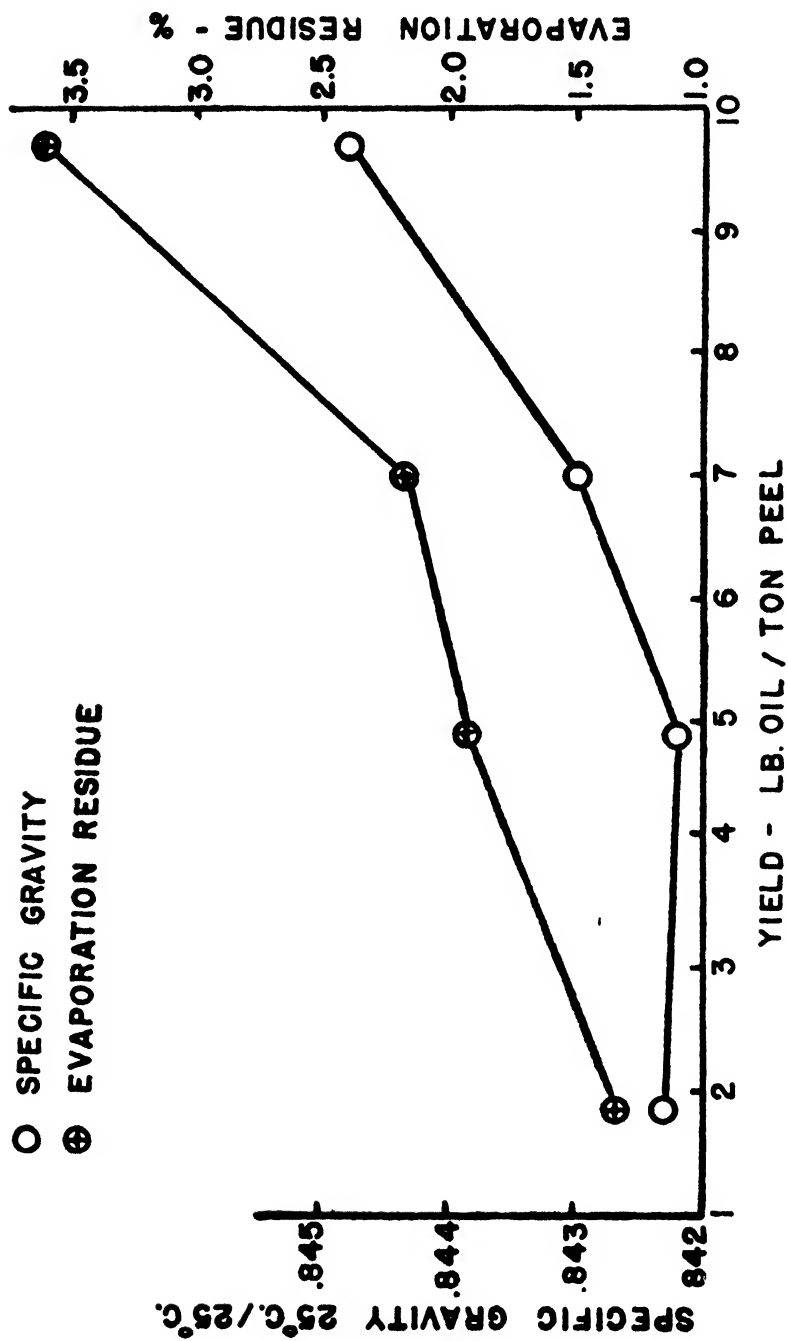


Fig. 1. Relation of specific gravity and evaporation residue of coldpressed orange oils to yield.

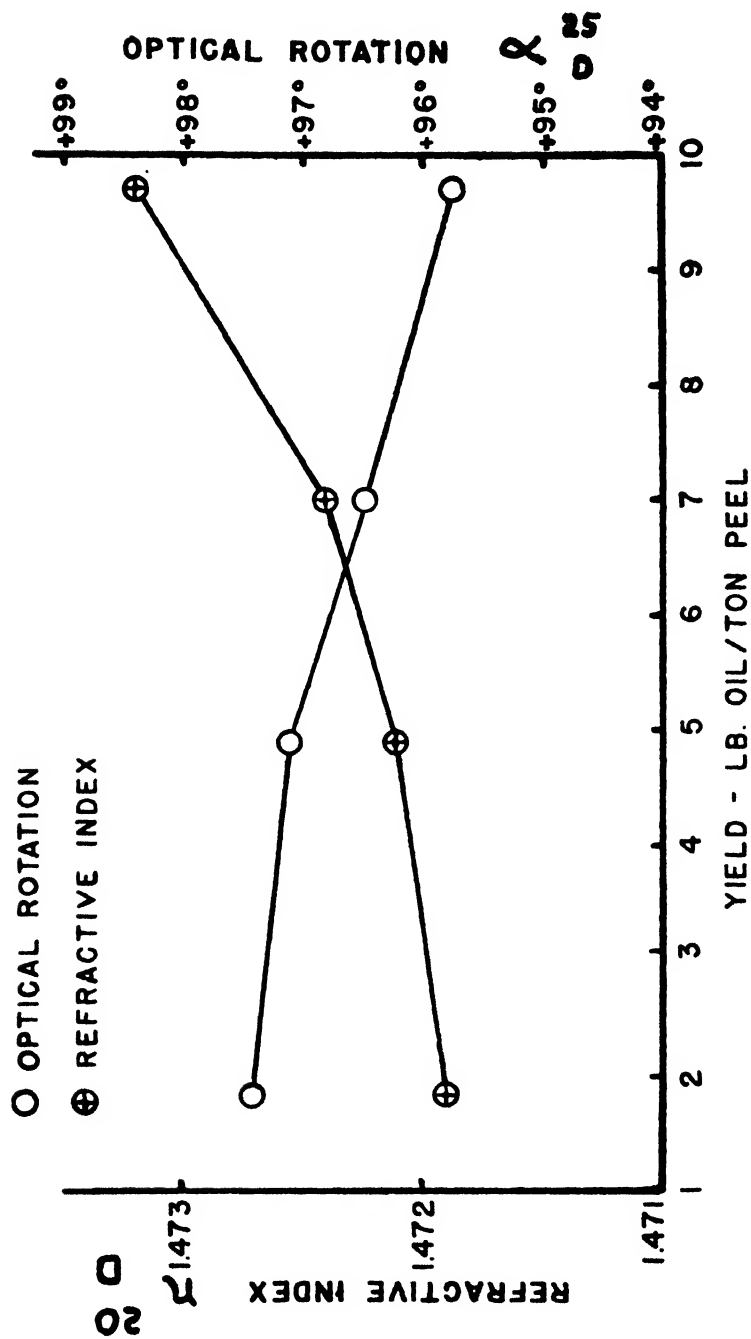


Fig. 2. Relation of refractive index and optical rotation of coldpressed orange oils to yield.



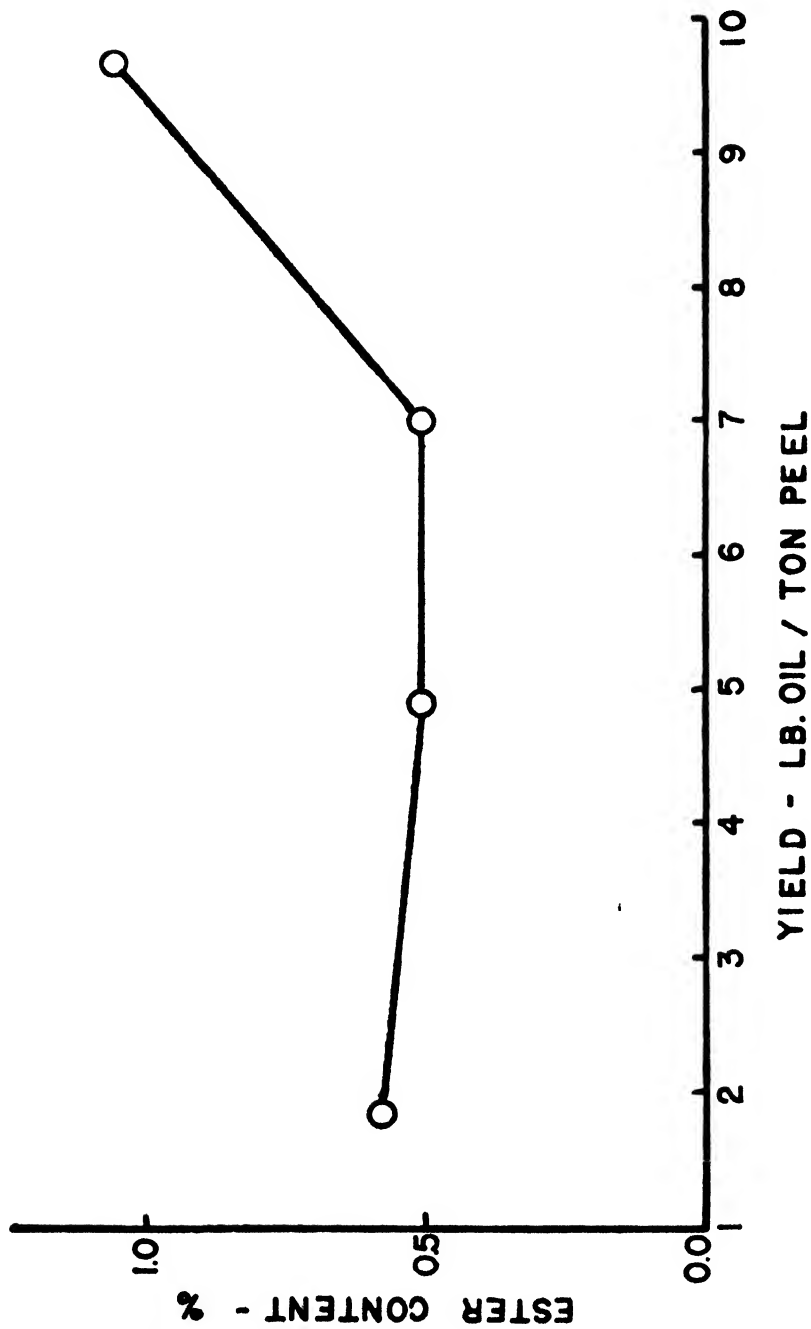


Fig. 3. Relation of ester content of coldpressed orange oils to yield.

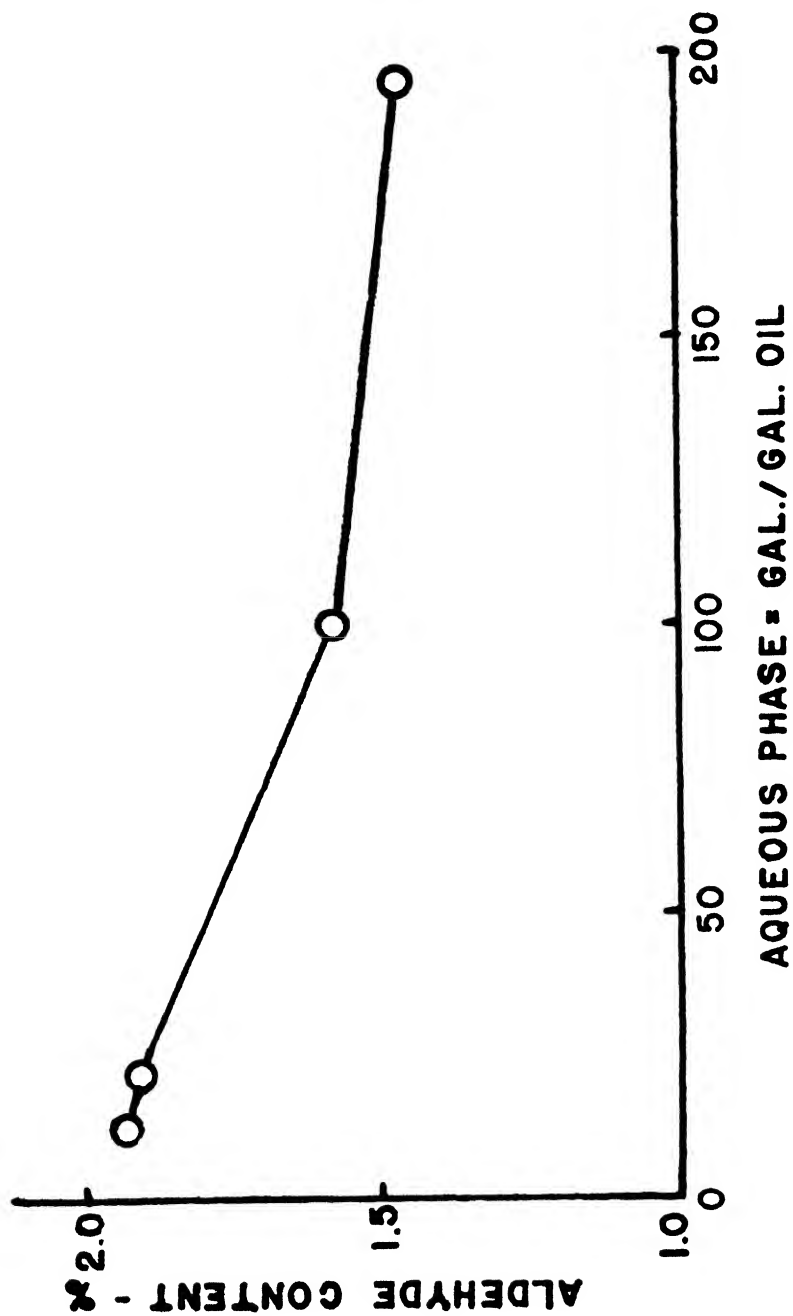


Fig. 4. Influence of the quantity of aqueous phase, which comes in contact with the oil during processing, on the aldehyde content of coldpressed orange oils.

### EFFECT OF AQUEOUS PHASE ON ALDEHYDE CONTENT

The flavor quality of oil of orange is dependent upon the many constituents of which it is composed. The aldehyde content of the oil, although not included in the U. S. P. specifications, is indicative of the *flavoring* qualities of the oil, and although other constituents are also very important from a flavor standpoint, aldehydes are a predominant factor in orange and other citrus oils. The data in Table 3 and Fig. 4 indicate that the aldehyde content decreases as the amount of aqueous phase, which comes in contact with the oil during processing, is increased. The average aldehyde content of the expressed oils of orange, which were secured during March, April, and May from the four plants at which material balance studies were made, varied from 1.47 to 1.93 percent. In one plant, where, at the suggestion of the authors, the water used in the process was reduced from extremely large quantities to an amount sufficient to give 100 gallons of aqueous phase per gallon of oil produced, while other variable factors were kept constant, the aldehyde content increased from 1.08 to 1.64 percent or an increase of 52 percent. Thus, it is evident that in order to produce an orange oil of high aldehyde content, the amount of aqueous phase that is allowed to come in contact with the oil during processing should be reduced to as small a quantity as is practically possible under operating conditions.

### SUMMARY

Commercial methods of production of oil of orange in Florida during the 1947-48 season have been studied and compared. The physical and chemical

properties of 25 samples of coldpressed oils of orange have been determined.

Quality of citrus peel oils, as indicated by their physical and chemical characteristics, is determined by the yield of oil obtained in any commercial process, regardless of the type of extraction equipment used, and also by the quantity of aqueous phase that comes in contact with the oil during processing, since the aldehyde content of the oil is largely determined by this factor.

The use of proper processing methods results in the production of essential oils in Florida which are of the highest quality and which consistently meet the specifications of the United States Pharmacopoeia. When manufactured carefully the quality of Florida oil of orange is equal or superior to essential oils from any other sources.

### ACKNOWLEDGMENTS

Acknowledgments are made to the commercial processors and manufacturers in the State of Florida whose earnest cooperation contributed much to the success of this work. Coldpressed oil samples used in this study were obtained from Essential Oil Producers, Inc., Dunedin; Pasco Packing Company, Dade City; Florida Citrus Oil Company, Lake Alfred and Fraser Brace Engineering Company, Tampa.

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# CITRUS PRODUCTS WASTE DISPOSAL

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The State Board of Health is charged by law with preventing pollution of the waters of the State by industrial waste. A decade or so ago very little pollution was caused by the citrus processing industry. This is no longer the case today. The phenomenal growth of the industry and the construction and enlargement of canning plants have caused the pollution load on our lakes and streams to reach alarming proportions.

Some idea of this burden may be gained from a consideration of a few figures derived from preliminary work on the problem. It has been determined that the volume of waste produced in canning operations at an average plant is approximately 50 gallons per case of 24 No. 2 cans. Marketing reports show that the seasonal production of canned fruit and juices in the State is in the order of 45,000,000 to 50,000,000 cases. This means that something like 2½ to 2½ billion gallons of waste are discharged into our lakes and streams each year. This estimate of waste volume has very little significance in itself. It does assume considerable importance, however, when studied in the light of the chemical and biological characteristics of

the uncontrolled waste from the average plant.

The composition of citrus processing waste varies over a wide range depending on the fruit processed and the form of the final product. There are marked differences in the waste produced in juicing and sectionizing operations; and obviously further differences in characteristics appear in plants employing secondary processes and by-products recovery refinements. Differences in volume and composition of the liquid waste are influenced to a great extent by the mechanical lay-out of the plant itself. For instance, where the can cooling water is wasted without being mixed with press liquor or peel bin drippings, practically 90 percent of the total plant waste can usually be discharged into receiving waters without causing significant pollution. In many plants that have been studied by this Bureau, it has been found that this tremendous volume of relatively clean water has been combined with other wastes with the idea of providing a high dilution factor and thereby obtaining satisfactory disposal. This has proved to be a mistake in practically every case. The effect has been to produce a highly polluted waste in unmanageable volumes.

Analyses that have been made on mixed effluents from various plants have given results approximately as follows:

Product	Total Solids (ppm.)	Organic Solids (ppm.)	5-day B. O. D (ppm.)	pH
Juice	700	550	350	6.5
Section	3500	3500	2000	5.8
Juice and Sections	1400	1200	600	7.2

It may help to clarify the picture of citrus processing pollution to present general data converted into more conventional units. If we may assume that all the waste now being produced is uniform in composition and contains average values of polluting characteristics, it can be shown that during the operating season the industry discharges approximately 18,000 tons of solids into receiving waters. In terms of B.O.D. loading the waste discharged by the citrus processing industry amounts to something in the order of 9,500 tons. To understand what this means, this load can be converted into equivalent volume of average strength sanitary sewage for comparison study. Average strength municipal sewage in Florida has values of total solids in the order of 800 ppm. and a 5-day B.O.D. strength of 200 ppm. In a 6-month operating season, therefore, the *daily* discharge of citrus processing waste is roughly equivalent to 60 million gallons per day of raw sanitary sewage, which would be equivalent to a population of approximately 60,000 people.

The analysis presented herein is not, of course, intended to reflect scientifically accurate results. It is intended to set forth broad approximations of the scope of the problem based on logical deductions from the data at hand.

#### THE POLLUTION ABATEMENT MOVEMENT

A generation ago it was common practice for municipalities and industrial plants to discharge their sewage and waste into any convenient body of water. This practice has grown out of the rapid expansion and development of the country and had acquired what many considered to be a vested right. As a result, however, many streams and lakes began to show signs of distress under the increasing pollution loads being imposed

on them. Obviously such practice could not be allowed to go on uncontrolled without causing complete destruction of the favorable attributes of surface and underground water resources.

The Congress of the United States, under the provisions of the Constitution, has control over all navigable waters. Under this authority the Federal Government has from time to time passed laws relating to the use of navigable waters and has delegated certain authority to the War Department and other agencies.

Control over nonnavigable waters is under the cognizance of the respective States. Under the police power of State government the various legislatures have adopted such pollution control measures as seem to be most suitable for their respective States. Florida, of course, has such legislation in the statutes and places the responsibility for supervision of water supplies and pollution in the State Board of Health.

The general stream and surface water improvement under the existing authority has been extremely disappointing. So much so, in fact, that many national authorities and various interested groups have for some time sought to obtain rather rigid Federal control of local pollution as a means of ending flagrant misuse of natural water resources. Accordingly, many so-called anti-pollution bills have been submitted to the Congress for consideration.

In the final hours of the 80th Congress a "Water Pollution Control" act was passed and became Public Law 845. This act deals with the pollution of interstate waters in or adjacent to any State or States.

It is the personal opinion of the writer that this is merely an interim bill, and

the next step will be Federal control of *intrastate* waters. A bill may be passed such as has been tried for years such as the Mundt Bill.

The Bureau of Sanitary Engineering may be considered to endorse Federal Water Pollution Control if it is true that satisfactory results cannot be obtained on the State level. The record to date would certainly indicate that the efforts of the responsible State agency have been something less than completely successful in bringing about correction of the generally bad situation. But when the problem is considered from a broad long-range viewpoint the Bureau feels that some measure of accomplishment has been achieved and that there is a fair prospect for substantial improvement in the near future. To substantiate this optimistic attitude the Bureau can cite the fact that detailed planning and engineering study by principal cities in the State have been underway and approved by the Bureau looking to the construction of some 88 projects covering both sewer extensions and treatment at an estimated cost of over \$30,000,000 in the next few years. Day by day contact with city officials and consulting engineers leads us to expect a considerable volume of construction in this field on the first approach of normal business conditions.

The only large item remaining to dilute this optimistic view is the relatively untouched problem of pollution attributable to industrial operations. The apparent magnitude of this item has been described elsewhere in this paper.

#### THE INDUSTRIAL WASTE PROBLEM

There are relatively few industries in Florida that cause the discharge of waste in volumes sufficiently great to constitute specific regional problems. Without any

intent to arrange them in order of value or volume the list would include mining, paper manufacture, and, of course, citrus processing including canning, molasses manufacture, and cattle feed prepared from citrus pulp.

The mining industry is fairly well concentrated in certain areas of the State where the raw material can be removed economically. In terms of economic value to the State the industry is extremely important; yet this industry has demonstrated its awareness of responsibility for solving its pollution problem by underwriting an extensive research study of the problem with the view to correcting existing bad practice in disposal of waste. Similarly the pulp and paper industry has sponsored the organization and administration of a research group known as the National Council for Stream Improvement. It is expected that both of the above-mentioned groups will in time obtain results which will be reflected in abatement of present pollution problems being created by these respective industries in the State.

In the opinion of the Bureau the citrus processing industry is in a less favorable position in respect to its contribution to the pollution of the waters of the State. This is due, of course, to many factors and extenuating circumstances of which this office is fully aware. The seasonal nature of the business, the variety of products processed, the further variations in waste composition due to mechanical design of plants, the broad range in type and character of waste receiving waters, all tend to complicate the problem and make a rational solution more difficult to obtain.

The Bureau is by no means unmindful of the work that has been done on this problem under the sponsorship of the

Citrus Commission and the Canners Association. Furthermore, it is well known throughout the State that several plant owners have gone to considerable expense and effort to develop methods of byproducts recovery and waste treatment. However, it must be conceded that much work remains to be done before a satisfactory treatment process is evolved that will not be prohibitive in cost.

#### SUGGESTED PROCEDURE FOR FURTHER STUDY BY THE CITRUS INDUSTRY

Mention has been made of the general pollution problem in Florida, the trend of thought on both the national and State level on methods of obtaining abatement of the problem, and some comment has been presented on the status of planning for treatment works by municipalities. Mention has also been made of the magnitude of the industrial waste load with some notes on action being taken by several of the more important industries in the State.

It seems logical to conclude from the above-mentioned review that there is an urgent need for a fresh approach to the problem of citrus processing waste. The Bureau, therefore, has made a preliminary study of this subject with the view to presenting the industry with a plan for an intensive investigation of the problem in the belief that the time for such an integrated approach is now at hand.

In the absence of a permanently established pollution control research agency such as that set up by the pulp and paper industry, the Bureau is prepared to offer its good offices as the preliminary research agency for the citrus processing industry. It is proposed that the industry, by any means it deems most suitable, provide funds for the detailed survey of

the problem and, at the appropriate time, establish a permanent research station with qualified full-time technical staff. It would be the principal function of the research station to pursue such lines of attack on the waste disposal problem as seem most promising of success according to results obtained in the survey proposed to be made under the general direction of the Bureau.

The Bureau has made an estimate of the cost of the detailed survey described above. This estimate assumes that full factual data on each processing plant in the State will be obtained. Such data will include the following items:

1. A detailed physical survey of the plant to determine the amount of water used; where water is used in each stage of the process; the rate of waste discharge at each point in the process; the chemical, physical, and biological quality of each component source of total waste.
2. Further physical study of the plant to investigate alternate waste collections systems and probable effect on total waste strength.
3. Correlation of water demand rates and waste discharge rates with fruit process production; correlation of waste characteristics with the various products of operation. From these data design values will be derived for use in future treatment research studies and in the design of treatment facilities.
4. Complete hydrological, chemical, and biological data on receiving waters; analytical studies designed to reveal data on degree of treatment required to maintain satisfactory quality in receiving waters; investigation of the influence of citrus process pollution in relation to the economic use of receiving waters. This will involve studies of potential as well as existing use for public water supply.

final disposal for treated municipal sewage, and recreation.

5. Assemble and evaluate existing data on treatment processes that have been investigated in the past and results now being achieved in studies now being made. The purpose of this item will be to screen out processes that have failed to give satisfactory results or which seem to promise little hope for success in order to channel research into more promising fields.

The cost of the study outlined above is estimated tentatively at about \$50,000 per year. The length of time required to accomplish the aims of the program will depend on several factors; perhaps 3 to 4 years may be required to define the problem in sufficient detail to satisfy the pollution abatement authorities and to get research studies advanced to a point where economical and adequate treatment processes are in sight. It is the considered view of the State authority—that is, the Bureau of Sanitary Engi-

neering of the Florida State Board of Health—that the industry will be more than repaid in financing the program to defend the State from a rapid deterioration in one of its most important attractions. According to conservative marketing estimates the annual cost will be in the order of one-tenth of a cent on each case of fruit produced.

This, then, is offered to the industry with a request that it be given an honest appraisal. The Bureau is presenting this prospectus with full knowledge of obstacles in the way of such a scheme, but with confidence that the industry will receive it in the spirit in which it is offered. The Bureau will be glad to meet with any committee or representative group from the industry to discuss the subject in more detail and consider any alternative that may be suggested.

One thing is certain: some action must be taken to advance the solution of this problem at a more rapid rate than is now being experienced if the State is to avoid outside interference in its local affairs.

## CANNING AND BYPRODUCTS RESEARCH AT THE CITRUS EXPERIMENT STATION<sup>1</sup>

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Lake Alfred

### INTRODUCTION

Excellent facilities for research in canning and byproducts have been provided at the Citrus Experiment Station through the cooperation of growers, processors, State and Federal agencies, and many

other persons, who are today interested in the welfare of the Florida citrus industry. The 11 research personnel now working in the canning and byproducts department at the Station includes three food technologists, three chemical engineers, four chemists, and one bacteriologist. All of the research being carried on at the present time is a result of the cooperation of personnel of both the Station and the Florida Citrus Commission. All of the personnel are desirous of doing research, which will benefit the

<sup>1</sup> Paper presented at the 61st Meeting of the Florida State Horticultural Society, West Palm Beach, Florida, October 28, 1948.



citrus industry as a whole, and not just any one particular group. We want to be helpful to both growers and canners, as well as to independent and cooperative organizations. Results secured from our research program can only point the way toward improvement in the citrus industry, and what the future of the industry will ultimately be depends on the desires and motives of all growers and processors.

One realizes how important research in canning and byproducts may be to the citrus industry when one considers how much of the citrus crop is going to the processing industries. Sixty-six percent (19,128,389 boxes) of the grapefruit harvested, 52 percent (30,104,341 boxes) of the oranges, and 20 percent (598,505 boxes) of the tangerines were processed during the 1947-48 season. Thus 55 percent of the total citrus crop harvested during the last season, or 50 million boxes out of 90 million boxes, went into canned, concentrated, or other processed products. This represents an increase of 11 percent over the amount which was processed in 1946-47.

A research program will be of help to the citrus processor if it produces results which will show how quality of processed citrus products may be improved. Research should also lead to the development of new products from citrus in both the processing and byproducts fields. If high quality citrus products can be produced and offered to the consumer at reasonable prices, demand will increase and overproduction will cease to be a problem. The increasing popularity of frozen concentrated orange juice, since its beginning in 1946, illustrates how a new high-quality product can rapidly become an important factor in the industry. The research program at the Station is

aimed at improving the quality of all types of processed citrus products.

#### CANNING RESEARCH

During the past year the installation of the equipment and machinery for the new canning plant was completed. Citrus juices have been satisfactorily processed at the Station since December 10, 1947, when the first pack of orange juice was canned. Using fruit from the Station groves and other groves in the State, 49 packs of orange, grapefruit, tangerine, and blended juices were processed. These packs yielded approximately 1,100 cases of juice, each case containing 24 9½ ounce cans. Approximately 2,000 gallons of juice were processed.

During the past season juice was canned from fresh fruit produced on the Station blocks, which had been maintained under different fertilizer treatments. Eleven packs were processed using fruit from blocks which had been treated with fertilizers containing varying amounts of potash, magnesium, and manganese. The quality of the canned product depends on the quality of the fresh fruit used, since very few products are improved by canning. Any factor, such as variety, rootstock, soil, rainfall, and fertilizer, which affects fresh fruit quality will be important in determining the quality of the canned product. Only fruit of high internal quality should be canned or concentrated. Fruit of poor internal quality should be diverted to other uses. By research on the effect of fertilizer practices on the canning quality of citrus juices our ultimate aim is to find out the type of fruit best suited for canning and how to produce it.

Spray treatments also affect fruit quality, and therefore, during the past season we put up some packs of juice from fruit

which had been sprayed with different types of materials. It is essential that new spray materials be tested prior to their general use in order to be sure that they will not be detrimental to the quality of the canned product. Organic spray materials may have an odor or taste which might penetrate into the juice of the fruit. A foreign musty odor and taste was detected in canned orange juice which was secured from fruit that had been sprayed with benzene hexachloride.

The utilization of grapefruit in canned orange-grapefruit blends serves as a good outlet for this fruit. Work is being done on the standardization of blends. We are attempting to determine what acidity, sweetness, proportion of the two juices, and other characteristics are necessary to give a blend of high quality and good consumer acceptance.

A plant for the concentration of citrus juices has been installed at the Station and was first used for the concentration of orange juice on May 7, 1948. Utilization of this plant for research on frozen concentrated orange juice is planned. Further work on the standardization of low solids orange juice by partial concentration is also contemplated, as has been pointed out by Mr. Atkins and Dr. Moore today in their discussion of this subject.

#### BYPRODUCTS RESEARCH

In the field of citrus byproducts Mr. Kesterson and Mr. McDuff have today reported on the work which they have completed on the production and properties of Floridian oil of orange during the 1947-48 season, and Dr. McNary has presented a progress report on the production of methane from the waste water of canning plants. Investigation of the

cause of the unpredictable instability of citrus molasses has been undertaken. Stabilization of citrus molasses is desirable, since excessive frothing presents difficult storage problems. The physical and chemical properties of 25 samples of molasses, which were secured from 13 processing plants, have been determined. Large variations were found in most of the characteristics of the samples. Here again we have a citrus product which needs standardization in order that a product of uniform quality might be offered for sale. The color varies from light tan to dark brown, total sugar content from 33 to 50 percent, pH from 3.9 to 6.2, and there were very large differences in relative viscosity. The question of instability has yet to be solved.

#### FLAVOR RESEARCH

The quality of fresh, concentrated, or canned citrus juices depends upon many factors. As pointed out by Plank (1) a rational method for grading the quality of any food product should be based on subjective (organoleptic), objective, biological, and external characteristics. Subjective (organoleptic) values are by far the most important in consumer evaluation of the quality of a food product. Taste and aroma are examples of subjective qualities, which so far have defied analytical measurement and therefore have to be judged on physiological sensations and psychological reactions. Objective properties such as color, Brix, and acidity can be determined by various methods of measurement. Under biological values may be included microbiological (bacteria, yeasts, molds) content, nutritive value, and enzyme activity. The presence of undesirable substances such as seed particles, and the type of packaging may be

classified as external characteristics. Any method for grading the quality of citrus juices should take into consideration these four categories of quality values.

Flavor has and always will be a pre-dominant factor in determining the quality of any food product, and this is even more pronounced in the case of citrus juices. Flavorsome products definitely

outsell those which have poor flavor qualities. Because of the vast importance of flavor as a factor in citrus juice quality, we are developing a taste panel hoping that it will be of assistance in the determination of the quality of experimental and industrial packs of citrus juices, that it may help to determine consumer preference, and that it may yield

TABLE 1

## DETERMINATION OF CITRUS JUICE QUALITY—FLAVOR PREFERENCE SCORE SHEET

Aroma	-----	Excellent	10
		Very Good	9
Ratio	-----	Good	8
		Fair	7
Body	-----	Borderline Plus	6
		Borderline	5
Bitter Extractives	-----	Borderline Minus	4
		Poor	3
Peel Oil	-----	Very Poor	2
Flavor Intensity	-----	Objectionable	1

## OFF FLAVOR

None	10	None
Questionable	9	Cooked
Slight	8	Musty
Definite—Not Disagreeable	7	Soured
Borderline Plus	6	Stale
Borderline	5	Tinny
Borderline Minus	4	Fruity
Disagreeable	3	Overripe
Very Disagreeable	2	Immature
Repulsive	1	Perfumey
		Putrid
		Pea-like
		Tomato-like
		Astringent
		Rancid
		Other -----

Overall Acceptance -----

Name -----

TABLE 2

## DIRECTIONS FOR USING FLAVOR PREFERENCE SCORE SHEET

*Factors Contributing to Flavor of Citrus Juices*

1. Aroma is detected by smelling the juice before tasting it.

2. Ratio refers to the relationship or balance between the sweetness and acidity of the juice.

3. Body of a juice is chiefly dependent upon the soluble solids present in the product and is judged by the feel of the juice in the mouth.

4. Bitter extractives refer to bitter constituents extracted from the peel, rag, or seeds of the fruit, but this factor does not include the peel oil.

5. Peel oil is the essential oil which is extracted from the peel.

6. Flavor intensity refers to the strength of *desirable* flavors. An insipid or weak flavor would be considered here. Do not include intensity of off-flavors in this category, but score them on other portion of score sheet.

7. Off-flavors are *undesirable* or foreign flavors which may be caused by such factors as bacterial action, use of poor quality fruit, methods of processing, enzymatic action, storage, and others.

*General Directions*

1. The product is to be graded on the basis of the taster's *personal preference*. The score given should indicate only the taster's *personal preference* for any factor, and does not necessarily indicate the quantity of any constituent present. For example, if a taster recognizes a high peel-oil content and does not like it, then

he will give a correspondingly low score to that constituent.

2. Compare a given type (fresh, canned, or concentrated) of juice with what you consider to be an excellent quality product for that particular type. For example, score canned juice on the basis of what you consider an excellent canned product, but do not score or compare a canned juice with either fresh juice or frozen concentrated juice. Likewise, fresh juice should be scored on a fresh-juice basis and frozen concentrated juice scored as frozen-concentrated juice.

3. Score each factor using the same scale of 1 to 10. Thus a score of 8 would indicate a "good" aroma, a "good" body, or a "good" flavor intensity.

4. Check and indicate with number (1 to 10) the degree of *individual* off-flavors which are present in the juice, and encircle the proper number to indicate the degree of *all* off-flavors.

5. The *over-all acceptance* score indicates the composite reaction of the taster to *all* the flavor factors including both desirable and off-flavors. Other factors, such as seed and other foreign particles, or color should not be taken into consideration. A score of 5 or above for the over-all acceptance indicates that *you* would *buy* the product for home consumption.

6. Do not make comments about your opinion of the juice while other tasters are scoring the product, since such comments may influence their judgment.

data which may assist in the determination of future standards of quality for citrus juices. We desire to present today a brief discussion of the preliminary work which has been done up to the present time in order that we might secure constructive criticism and suggestions from this group.

The flavor preference score sheet (Table 1) is the first of a series of score sheets which we hope to develop to cover all subjective, objective, biological, and external properties which contribute to the quality of citrus juices. After the complete series of score sheets has been developed, we hope to have as accurate a method as possible for the determination of the quality of fresh, concentrated, or canned citrus juices. We do not intend the score sheet (Table 1) to be used by large consumer groups but only by small groups where direction and supervision can be given. Intelligent understanding and use of this score sheet is necessary if consistent and reliable scores are to be obtained. The seven characteristics of citrus juice which are considered to attribute to its flavor are: Aroma, ratio, body, bitter extractives, peel oil, flavor intensity, and off-flavor. Directions for grading the juice using the flavor preference score sheet (Table 1) are presented in Table 2. This direction sheet should be given and explained to all tasters, who should also have an opportunity to taste samples of juice which contain bitter extractives, peel oil, and various types of off-flavors in order that they may score the juice intelligently.

The juice to be scored is placed in a one-gallon thermos jug, which has an attached faucet, and this container is then placed in a desirable and convenient location. By the use of the thermos container a juice temperature of 40° to 50°F. is maintained. Three-ounce untreated paper cups are used. Two samples of juice are scored each day, one sample being put out at 10:00 a.m. and the other sample at 3:00 p.m. The persons on the taste panel sample and score the juice at their convenience during a period of approximately 1 to 2 hours. About one-half of the tasters on the panel are from States other than Florida. Thus far it has been possible to have 20 to 30 persons score the juice samples each day. However, because of other duties, it is impossible for everyone on the panel to score all samples every day.

We are also attempting to develop a small panel of five or six persons who through training and practice may become skilled tasters of citrus products. Also, eventually consumer preference tests using larger groups of men, women, or children may be undertaken. Standards for citrus juice quality should be based upon consumer preference rather than upon the preference of research personnel, growers, or processors, and therefore, large scale consumer testing should be done in those parts of the country where most of the citrus juices are sold and consumed.

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INSTITUTE**



## IMPRESSIONS OF CALIFORNIA

L. L. CHANDLER  
Goulds

Since 1939, I have made several trips to California to make a study of the avocado and lime industry, because my citrus operations in Dade County were on the decline, and I wanted to educate myself on the subject of avocados and limes and substitute them for citrus.

In the past 2 years, I have made three such visits to California and became acquainted with some of the officials of the industry there. I express my thanks for the completeness of their courtesy in extending all the information pertaining to their industry and their very evident concern as to what was going to be done in Florida. I especially thank Mr. George B. Hodgkin, General Manager of the Calavo Growers, Inc., other officials of that organization, and various individuals throughout the State.

I had heard many glowing reports concerning their industry. Some of them I found to be true, but I found their industry to be made up of people, the same as ours here in Florida, worried with their problems in the same manner as we are. I found them to be very concerned as to the future production and competition from Florida.

Avocados are produced in California in Santa Barbara, Ventura, Los Angeles, San Bernadino, Orange and San Diego Counties principally. The principal lime production is in the San Diego County area.

The avocado acreage in California has grown from 2,567 acres in 1927 to a

total of approximately 18,000 acres now, with 2,000 to 3,000 of this acreage non-bearing. These figures are not exact, because at this writing, statistics are not available as to the exact acreage. This increase is partially due to a replacement program going on in California, in which growers of other crops are replacing some of these with avocados, as the record of profits on avocados seem to warrant their doing so. In and near some of the principal cities, some of the older avocado plantings are being absorbed in real estate developments. This appears quite noticeable when traveling through the area. New plantings or replacement plantings, however, are much greater than the displacement by real estate or industrial development.

I was impressed to learn that the average acreage of avocados on a per-grower basis is only 3 to 4 acres. This was brought about by many growers being engaged in the production of other commodities, and then planting some odd corner of their holdings to avocados. Also, it was found that some of the rougher land that wasn't so well suited to the growing of other commodities would lend itself to avocado production.

There are some 800 different varieties of avocados known in the State. However, the most of these are not grown commercially. It was learned long ago that the Fuerte variety, while not as cold resistant as some others, yet was sufficiently so, with the result that today the acreage is heavy to that variety. Of the fruit now produced in



that State, 75 percent to 80 percent are of the Fuerte variety. A peculiar circumstance, very interesting to Florida growers I am sure, is that this variety often has more than one blooming period and may set as many as three crops during one year. We are not accustomed to having that sort of thing occur in Florida. There are very few West Indian varieties produced in California because they are not as cold resistant as the Mexican and Guatemalan types. All varieties in California are subject to biennial bearing, especially the Fuerte.

The annual production of avocados in California ranges from 40 to 50 million pounds per year. This is due for a considerable increase as time passes, and I predict that in 5 to 10 years' time, the avocado production in California will double its present volume.

Avocados mature and are marketed principally during the months of December through May. However, some are produced and shipped during the entire year. There is a considerable increase in the planting of those varieties which will mature during the summer and fall months. This is a result of a natural process of grower thinking, in that such a grower hopes to produce some of his fruit out of season, so far as the general crop in California is concerned. This is being recognized, however, and the leaders of the industry in California are strongly advising against growers in California planting summer and fall maturing varieties because of Florida and Cuban competition, based on the fact that production costs in California per acre or per unit are higher than in Cuba or in Florida. There is an idea prevalent here, that little or no shipments of avocados occur during the summer or fall months from California, but

this is untrue, since California ships practically the same quantity of fruit produced during the period when Florida matures and ships its major crop. In fact, the present annual shipments from Cuba, Florida, and California covering the period from June to December are surprisingly near the same in volume.

I refer in this talk to the lime industry in California, but it is not of major consequence and does not appear likely to expand sufficiently to offer serious competition to the Florida producer of limes. There are two main reasons for this. First, the commercial crop of limes in California matures principally during the midwinter months and demand for limes is not great at that time of the year. The buying habits of this Nation demand limes during the warm months of the year and not in the cold ones. Second, there is a tremendous production of lemons in California ranging from 18 to 24 million bushels per year, and with what is considered by many to be an overproduction of lemons, there is no real incentive to brave the danger of cold and the other hazards of production in order to produce limes in California. There is usually a sufficient supply of lemons to supply the demand for that type of fruit within the State and nationally, so far as the lime grower in California is concerned.

At the present time, I predict the lime grower in Florida has little to fear from lime production or competition from California, and I believe I can safely predict that, when the Florida lime industry puts its house in order by the establishment of higher juice content, grade, and quality standards, that there will be a strong cooperation with the California industry as to the dispo-

sition of the Florida crop, both in its fresh form and processed. At the present time there is a fairly large importation of limes from Mexico into California for consumption and reshipment, but this importation is handled under difficult circumstances and without much profit to the California operators. There is an impression among Florida growers that Florida limes cannot be shipped to California. That is not true, because if they are fumigated or treated as required by regulation, they can be shipped into California under the same conditions that Mexican limes are now shipped.

It is interesting to compare some of the costs of producing avocados in California and Florida. I shall not attempt to quote a lot of statistical information, all of which is available to those interested. In the beginning, a grower in California must pay an average of \$1,000 or upward per acre for the land on which to plant his orchard. In Florida, an average of \$250 per acre will usually buy the best grade of suitable land for either avocados or limes.

The preparation of the land for planting in California will average \$200 to \$300 as compared with \$100 to \$150 per acre in Florida. This is partially brought about by the necessity for supplying water, which is a different situation compared to Florida where often we work to dispose of excess water. Certain types of terracing on the sides of hilly or rolling land must be done. Labor costs are generally higher, as the labor rate is greater. The cost of the trees is greater, although I found a much higher degree of perfection in the growing of young trees for planting than is usually done in Florida. Where it costs 85c to \$1 for a young avocado tree in Florida, it will

average \$2.50 per tree in California. I do not believe this is wasted money, as they maintain very rigid standards of variety and take great care to produce the best tree possible. The Florida grower can learn a good lesson in this respect. In the past, generally, seedling trees were planted and then budded or grafted later. There is a sharp trend to the use of grafting or tip budding in the nursery, as is practiced generally in Florida now.

In Orange County, one of the principal avocado producing counties in California, Agricultural Extension Service records disclose that over a 10 year average, 75 trees were planted per acre. There is a strong trend in new plantings to either reduce this by as much as one-fourth to one-third, or plan to remove some of the trees when they begin to crowd each other. The cost or investment per acre in Orange County during the period beginning in 1930 and extending through 1947 ranged from a low of \$1,698 per acre to \$2,540 per acre, with a 10 year average of \$1,905 per acre. Not all of this cost is represented in the original planting, but covers the investment per acre up to the time when the grove has reached, or is in commercial production. These figures are taken from records of the more efficiently operated groves, and show an annual cash cost per acre operation of \$153.67.

After the grove is planted, the grower in California is faced with two very major hazards. First, the supply of fresh water is now transported from the Colorado River, Boulder Dam, and other distant places, resulting in high cost to the grove owner. Recently, these grove owners were placed on a water quota, because of very dry conditions. There is a great fear in California that the

water supply in the future will not be sufficient to supply the demands of agriculture, industry, and human consumption. Irrigation costs range widely from as high as \$153.85 per acre down to nothing, with an average of \$58.42 per acre. Second, frosts and subfreezing temperatures are likely to occur in California and this results in their planting the cold-resistant varieties.

The greater number of growers find it necessary to supply heater systems of various types to protect the trees against cold, except in those proven local spots where air drainage or other conditions do not result in so much cold. The type of planting, the varieties, the circumstances which effect the maintenance and growing of their trees, results not only in a greater expense to the grower than in Florida, but a period of 5 to 8 years elapses before their trees reach commercial production. During this period, the California grower expects to spend \$1,500 per acre and upward to reach that day of production when his grove is self-supporting. In Florida the grower expects to duplicate this in a lesser period of time and generally at about one-third the cost. This is true for both avocados and limes. I do not have accurate or detailed figures for the cost of installing or operating freeze protection.

Just what the primary contributing factors are that cause a lesser production per tree or per acre in California, I do not know, but well kept orchards there do not average more than 75 to 100 bushels per acre per year. There are some that do. During the 6-year period from 1939 to 1945, the average annual yield per acre amounted to 2,200 pounds of avocados as compared with 1,140 pounds during the 6-year period from

1927 to 1933. The highest average yield on record was 3,220 pounds per acre in 1943. This yield situation is reassuring to the grower in Florida, but he should not be misled by this, because the California grower is busily improving his situation. There is a wonderful system maintained by the State and Federal Governments working on all of the problems and the grower cooperation seems to be excellent. I predict the average yield per acre will greatly increase in California in the years to come.

Because I think you are already informed, I shall only touch lightly on yields in Florida. There are many older planted groves of low-producing varieties, including seedlings, and the record of yields on those groves is not good; in fact, it will just about equal the California production. The industry is new in Florida. The major new plantings in Florida are of varieties that we know are now producing, including the average of storm losses, etc., 2 bushels per tree and upward. One variety in Florida this year was known to produce 4.75 bushels of fruit per tree, with approximately 70 trees per acre. With approximately the same number of trees per acre, the grower in Florida has every right to expect a yield of double or three times that now produced in California per acre. This yield situation is not so true where limes are concerned, as the lime trees in California can and do produce about equally to those in Florida.

There is a wide range of avocado yields among varieties in California and the growers there are doing a great deal of replacement and top grafting of poor yielders to correct this situation. I strongly recommend the Florida grower who owns the poor yielding varieties to do the same thing.

The average avocado grove in California, because of their history of profits primarily, carries a value today of \$2,000 to \$3,500 per acre. A grower will have invested \$2,000 and upward to have produced this grove to a commercial bearing stage where it will support itself.

The matter of harvesting, marketing, and distribution, including those companion problems of promotion, advertising, etc., is one wherein the California industry is far advanced over Florida. The California grower is surrounded with a different set of circumstances and economic conditions, and I think it is much easier for a closer cooperation to exist among the California growers as a result. The California grower finds himself a great distance from the heavy population centers east of the Mississippi. He finds himself associated with other commodities, which through similar circumstances, have developed a much higher degree of cooperation, together with more rigid standards all the way. Again, slightly over 4,500 growers own the industry in California today, which indicates that the big bulk of those growers do not own an acreage sufficient to put them in the marketing as business individuals. This has resulted in the economic necessity for this multitude of small growers to join their efforts in the marketing of their product.

Twenty-five years ago, there was created a cooperative organization, the Calavo Growers, Inc. There was created another cooperative, Calavo, Inc. These two organizations have functioned ever since. They started in a small way when the industry was young and they have gone through all of the headaches of growing up as an organization. There are at present nearly 3,700 members of these two organiza-

tions. They elect district representatives or directors, who in turn elect an executive committee, employ a manager and other necessary personnel. Calavo Growers handle or direct the harvesting, own and operate the packing houses, and do the entire job until the commodity is packed and loaded for distribution to market. Calavo, Inc., handles the distribution and selling. The membership, directorate, and personnel are identical in both organizations. The two organizations are created because of certain technical requirements and it is believed that a better job is done because of having both.

I mention and hereafter refer to them as Calavo, as they are the largest organization and control through their membership approximately 73 percent of the production in California. In most instances they control 90 percent or more of shipments leaving the State. There is another smaller cooperative, and the difference between the two groups is that Calavo, because of their major production being small-sized fruit, have built up over this period of time, a system of selling fruit by size, where the other organization, composed of growers who own varieties producing large sized fruit, concentrate their efforts on selling their fruit by weight rather than by size.

Please remember that more than three-fourths of all avocados produced in California are of the Fuerte variety and this variety produces small-sized fruit as compared with those generally produced in Florida. Their most favored size is 24 avocados in a flat holding 13 pounds net weight. They use only two types or sizes of packages. However, they do produce and sell out of the remaining one-fourth of their crop, many of the varieties which will include larger sizes,

different shapes, different colors, including some that are almost black when matured. Some of these varieties have softer skins and some have harder skins even to what amounts to a shell. The Fuerte is the outstanding and leading variety, and largely dominates the entire California system of marketing avocados. There are a few independents who, because of special connections or circumstances, market their own fruit, but these, together with the smaller co-operative, principally sell their fruit in California.

Let us follow briefly the system used by Calavo, as it is much the larger. Calavo has set up in each of 34 major cities of the United States a distinct sales office, and in connection with each, a refrigerated or storage facility, and these are entirely owned or leased by Calavo. Calavo has set up what appears to be an intricate or highly complicated system of records, but which they believe to be very necessary to accomplish their aim, which is complete grower control of the harvesting, packing, and selling of their fruit. Estimates are made and kept constantly for each of the groves in this organization, based on history of production, grower estimate, company estimate, variety, season of maturity, etc.

In the sales office at Los Angeles, which is the head office and at all times has the final authority in making decisions of every kind, this inventory of the crop to be disposed of is checked, and at the beginning of each month, depending on the circumstances, a quota of shipments for that month is adopted and each grower is informed how much and when to pick his fruit and deliver it to the packing house. This is adjusted in the office of their Field Manager when circumstances make it necessary,

but the final decision always rests with the main office at Los Angeles under the authority of the General Manager. The sales office then makes a quota governed by all the factors involved for each of their 34 sales offices, and in addition thereto considering all factors, sets the sales price of this fruit.

Constant records are kept of the fruit as it is picked, while it is in the packing operation, while it is in transit, and as it is being sold. Necessary adjustments are made from time to time, but in every instance, final authority remains with the main office at Los Angeles. The main sales office in Los Angeles is completely informed as to conditions everywhere, including competition, domestic and foreign, competition with other commodities, and all of such factors. Cash track or f.o.b. sales are not made as a general policy, because this group feels and believes by their experience that they wish to handle the entire sales all the way through to the retailer, and in turn, the consumer, and they do not sell their fruit f.o.b. and thereby create competition within the markets. This is not adhered to in every instance, but it is their policy. The price thus fixed is passed on to the purchaser of the fruit and the price to the consumer is even checked, and to a large degree controlled, because if a handler does not cooperate in this program, he simply doesn't get any more fruit.

After the sales are made, accountings are made to the grower on a pooled basis, based on variety and grade. Pools are usually for 30-day periods. Since we were shipping fruit during the month of June, let us view that month. From California there were shipped 62 varieties of avocados, and the price, as deemed advisable by Calavo, ranged

from \$1.80 to \$5.00 delivered per 13-pound flat throughout the markets. Many of these 62 varieties constitute only a small part of their shipments. The June pool was paid 30 days after the pool had ended, permitting time for collections, recordings, etc. It is remarkable to note that the original quotas as to picking and price received was maintained, and slightly exceeded. This brought about a complete moving of the quota of fruit the growers had that should have been moved in that period.

This organization goes further in order to accomplish what I have described. Prior to the beginning of the season, as recommended by the General Manager and approved by the Board of Directors, there is adopted a standard which permits only those proven acceptable varieties being shipped under their first grade brand "Calavo," and this is divided into 4, 3, 2, and 1 Star. Other varieties not so desirable, as proven by their own records, are placed in "Bueno" brand and likewise divided, and still others cover the less desirable varieties or grades.

A vital question now arises. What did all of this effort produce in net returns to the grower? They have had their ups and downs in the markets. They have gone through the human upheavals and differences. It has not been easy, but for their fiscal year ending October 1st, 1947, they sold their entire output of 1,748,268 13-pound flats for a net return to the grower of \$2.53 per flat, or 19½¢ per pound. I need not say that this record was not even nearly approached by Florida sales for the same period, even though the Florida crop was light as a result of the 1945 hurricane.

To sum up the impressions gained—California has many natural advantages

for producing the type, size, and quality of fruit they do. California is making use of their advantages to a better degree, I think, than Florida is taking advantage of those circumstances which are favorable to Florida. California has promoted the buying habits of this nation to want avocados of small size. It was to their advantage to do so. They have worked at it for years. I don't blame, but commend them for so doing. Florida has many natural advantages and produces generally larger-sized fruit, but can produce fruit of the smaller sizes by planting the right varieties. Both areas can produce avocados of excellent quality. Florida will have to work toward establishing demand for larger sized avocados in the next few years to come.

California suffers from a lack of water generally, and cold weather. Florida suffers at times from too much water and hurricanes, and sometimes from cold, but I can't help feeling and urging the Florida avocado grower not to sell the Florida avocado industry short. The things that need correcting should be corrected, such as establishing or standardizing a lesser number of packages, adopting better methods of handling the fruit from harvesting to the consumer, and adopting standards of picking the fruit when it reaches the proper stage of maturity. Certainly, either through proper associated independent efforts or cooperative methods, adoption of grower-controlled methods of distribution and sales is needed. Florida growers must put their house in order.

In my judgment, the Florida avocado grower has a greater possibility for profits than the California grower will have in the years to come, because the lands on which he produces his crop can

be bought for an average of one-fourth the amount per acre that it costs in California. The preparing of the land, the planting and maintenance of the groves to commercial production can be done for one-third to one-half the sum it costs in California. The maintenance of the grove after it has reached production on an annual per-acre basis can be done at lower cost than in California, and the Florida grower may expect a yield of from two to three times per acre from his grove if it is of the right varieties, efficiently and properly cared for. Certainly with this picture, the Florida grower has a right to be encouraged.

The records disclose that less than one-half pound of avocados are consumed in the United States annually per capita. Even in Los Angeles, residents are only consuming 5 pounds per capita per year. In New York, the consumer is only eating 1 pound and a

fraction per capita. Certainly we need have no great fear at present of overproduction. All we need do for years to come is to intelligently handle our distribution and selling, and cause those who now eat avocados to simply eat more, even though we develop no new consumers.

As the results of my California study, and being interested in the production of avocados and limes in Florida to the extent of nearly 100,000 trees, the strongest impression I have gained is the necessity for a full and close cooperation between the industry in California and Florida. Nature has endowed those two States with a difference of season that makes it easily possible to accomplish this. I strongly advocate the closest cooperation, even to joint marketing, distribution, promotional, and advertising programs. To that end, I am working very hard and pledge my support.

## CONSUMER PACKAGING OF TAHITI (PERSIAN) LIMES

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The growing and marketing of Persian limes is a very important industry in southern Florida. Within a very short time, it has grown from a very small specialized industry to one of considerable size until in the season of 1944-45 it reached a peak of 218,693 boxes. The production has decreased considerably from that time until in the 1947-48 season only 161,687 boxes were produced. A

large percentage of this decrease has been caused by hurricanes and floods, but the lack of a ready sale has also been an important factor in this decrease in production.

Even with this decrease in production, there has not been a ready sale for all the fruit produced since the war. Consumption has been less than production and every year a large amount of limes go to waste either after having been shipped or at the point of production. It is very important, therefore, that research be done to find ways and means of selling more and better limes.

Limes are sold in competition to lemons, especially during the summer months, which stand up better and for a longer period of time than do limes. Not only are most of these lemons cured before shipping, but they are also held in storage for a period before shipping in order to discard the fruit with a tendency to rot, thus only healthy non-infected fruit are shipped.

Limes are picked when very immature and thus tend to lose excessive moisture as the protective wax coating is not present to the extent on immature limes as it is on mature limes. In order to reach an early market, many limes are picked too green and in addition to having poor keeping quality do not contain as much juice as the more mature fruit. We have educated the public to demand a small green lime when this is not the natural state of a mature fruit. The lime is mature and has the highest percent juice just before it turns yellow. If the lime is allowed to mature normally, it is then too large and considered off color for the existing market. The tendency has been to pick smaller and greener fruit until we have reached a point where the fruit will not hold up for any length of time because of the initial low juice content and excessive drying out of the fruit. Until such a time when more mature limes will be accepted, we must find ways of lengthening the shelf life of limes we now send to market.

Blossom-end rot of Persian limes is also a big factor in the marketability of this fruit. It is very serious, especially during the summer months in Florida limes, and is another big factor causing the wholesale and retail buyers as well as the housewife to favor the purchase of lemons instead of limes. Blossom-end rot starts as a physiological disorder at the

blossom end, with decay setting in the weakened tissues secondarily.

Even with the knowledge of the factors affecting the poor keeping quality of Persian limes, very little is done to correct them. Very few limes are refrigerated or packaged in such a manner as to give them a longer shelf life and thus a better sale.

It is with the above mentioned conditions in mind that research on the consumer packaging was undertaken by the University of Miami. We are hoping to find, through the present and additional research, better methods of growing, harvesting, packaging, and transportation of limes resulting in a bigger demand and larger industry. To prevent the excessive drying out, an extensive experiment on wrapping materials for limes was set up. It is evident that a whole new type of packaging and marketing is necessary to improve the salability of this fruit. A consumer package for limes will necessarily have to have a good moisture-proofness as well as an attractive appearance. It would have to hold up under various conditions of transportation and temperatures.

We have conducted two separate tests at both room temperature and 45°F of 20 different types of wrapping materials to find the best possible protection for our Persian limes. One test was made with limes harvested during the winter months, January, February, and March, and the other made with limes harvested during the summer months, July, August, and September. All limes used in the two experiments were from the same grove having had the same cultural treatment and were of the same maturity, that state generally used and considered commercially mature yet actually quite immature. This maturity was chosen be-



**TABLE I**  
**EFFECT OF VARIOUS WRAPPING MATERIALS AND TEMPERATURES ON THE KEEPING QUALITY OF PERSIAN LIMES HARVESTED DURING WINTER MONTHS**

WRAPPING MATERIAL	STORAGE TEMP.	WINTER MONTHS											
		1 week	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks	7 weeks	8 weeks	9 weeks	10 weeks	11 weeks	12 weeks
		M.F. <sup>1</sup> /wt	M.F. <sup>1</sup> /wt	M.F. <sup>1</sup> /wt	M.F. <sup>1</sup> /wt	M.F. <sup>1</sup> /wt	M.F. <sup>1</sup> /wt	M.F. <sup>1</sup> /wt	M.F. <sup>1</sup> /wt	M.F. <sup>1</sup> /wt	M.F. <sup>1</sup> /wt	M.F. <sup>1</sup> /wt	M.F. <sup>1</sup> /wt
		loss	loss	loss	loss	loss	loss	loss	loss	loss	loss	loss	loss
Vinylite 20 ga	R.T. <sup>2</sup>	100	0.89	100	2.99	100	4.81	93.3	6.76	86.6	8.47	53.3	40.0
P9V 37% tri-ox- ylen borate.	45°F.	100	100	100	0.78	100	1.17	100	1.57	100	1.58	100	1.93
	45°F-RT <sup>3</sup>	100	100	100	0.78	100	1.17	100	1.57	100	1.58	100	1.93
Phofilm 75 ga	R.T. <sup>2</sup>	100	0.87	93.3	3.02	100	4.63	86.6	6.33	80.6	8.00	60.0	40.0
N F.	45°F.	100	100	100	0.27	100	0.58	100	1.02	100	1.15	87.5	1.42
	45°F-RT <sup>3</sup>	100	100	100	0.27	100	0.58	100	1.02	100	1.15	87.5	1.42
Lumarith (Cel- lulose ace- tate) (100P-912)	R.T. <sup>2</sup>	100	5.34	66.6	12.93	46.6	18.48	0	23.02	26.93	100	8.19	100
	45°F.	100	100	100	1.60	100	2.75	100	5.39	100	6.15	100	12.99
	45°F-RT <sup>3</sup>	100	100	100	1.60	100	2.75	100	5.39	100	6.15	100	12.99
Sylphwrap PB 6 DS	R.T. <sup>2</sup>	100	8.12	86.6	17.37	22.77	66.6	24.99	100	100	30.53	46.6	13.3
	45°F.	100	100	100	0.48	100	0.75	100	1.00	100	1.90	100	2.81
	45°F-RT <sup>3</sup>	100	100	100	0.48	100	0.75	100	1.00	100	1.90	100	2.81
Cellophane 300 ga. No. 149 Exp. Film.	R.T. <sup>2</sup>	100	2.39	93.3	7.37	80.0	11.41	80.0	16.21	80.0	19.57	80.0	0
	45°F.	100	100	100	0.81	100	1.38	100	2.60	100	2.79	100	4.00
	45°F-RT <sup>3</sup>	100	100	100	0.81	100	1.38	100	2.60	100	2.79	100	4.00
Check (No wrapper)	R.T. <sup>2</sup>	100	7.56	100	15.79	100	23.21	80.0	26.41	0	32.66	42.85	46.36
	45°F.	100	2.52	100	4.59	100	5.96	100	9.75	100	11.51	100	14.03
	45°F-RT <sup>3</sup>	100	2.52	100	4.59	100	5.96	100	9.75	100	11.51	100	14.03
Vinylite 20 ga P9V (chem. treated)	R.T. <sup>2</sup>	100	2.01	86.6	4.75	73.3	8.02	66.6	9.77	66.6	12.13	53.3	13.73
	45°F.	100	0.46	100	0.92	100	1.24	100	2.22	100	2.33	100	2.91
	45°F-RT <sup>3</sup>	100	0.46	100	0.92	100	1.24	100	2.22	100	2.33	100	2.91
Phofilm 20 ga N.L.	R.T. <sup>2</sup>	100	0.41	100	1.99	100	4.54	73.3	5.69	66.6	6.37	66.6	8.09
	45°F.	100	0.14	100	0.33	100	0.44	100	0.78	93.0	0.84	93.3	1.19
	45°F-RT <sup>3</sup>	100	0.14	100	0.33	100	0.44	100	0.78	93.0	0.84	93.3	1.19
Vinylite 20 ga P9V (Dowicide 6-37%)	R.T. <sup>2</sup>	100	1.72	93.3	4.43	93.3	8.51	66.6	10.33	60.0	13.23	33.3	14.89
	45°F.	100	0.39	100	0.81	100	1.08	100	1.18	100	1.84	100	2.38
	45°F-RT <sup>3</sup>	100	0.39	100	0.81	100	1.08	100	1.18	100	1.84	100	2.38
Vinylite N2 20 ga (chem. treated)	R.T. <sup>2</sup>	100	1.87	100	5.20	100	9.30	86.6	11.06	73.3	14.25	33.3	16.01
	45°F.	100	0.65	100	1.11	100	1.51	100	2.56	100	2.56	100	3.13
	45°F-RT <sup>3</sup>	100	0.65	100	1.11	100	1.51	100	2.56	100	2.56	100	3.13
Vinylite 20 ga P9V (Special Chem. Film)	R.T. <sup>2</sup>	100	2.46	86.6	6.10	56.6	9.97	66.6	11.65	60.0	14.41	40.0	16.37
	45°F.	100	0.56	100	1.16	100	1.71	100	2.78	100	2.93	100	4.06
	45°F-RT <sup>3</sup>	100	0.56	100	1.16	100	1.71	100	2.78	100	2.93	100	4.06

<sup>1</sup> M.F. = Marketable Fruit. <sup>2</sup> R.T. = Room Temperature (65-75°F.). <sup>3</sup> 45 F-RT = Fruit held 4 weeks at 45°F. then removed to R.T. (65-75°F.).

TABLE I—Continued  
EFFECT OF VARIOUS WRAPPING MATERIALS AND TEMPERATURES ON THE KEEPING QUALITY OF PERSIAN LIMES HARVESTED DURING WINTER MONTHS

WRAPPING MATERIAL	STORAGE TEMP.	1 week	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks	7 weeks	8 weeks	9 weeks	10 weeks
		M.F. <sup>1</sup> %wt	M.F. <sup>1</sup> %wt	M.F. <sup>1</sup> %wt	M.F. <sup>1</sup> %wt	M.F. <sup>1</sup> %wt	M.F. <sup>1</sup> %wt	M.F. <sup>1</sup> %wt	M.F. <sup>1</sup> %wt	M.F. <sup>1</sup> %wt	M.F. <sup>1</sup> %wt
		loss	loss	loss	loss	loss	loss	loss	loss	loss	loss
Phlofilm 100 ga N 1.	R.T. <sup>2</sup>	100	0.26	100	1.20	73.3	2.70	60.0	3.65	53.3	4.90
	45°F	100	0.16	100	0.37	100	0.66	75.0	0.71	62.5	0.85
	45°F-RT <sup>3</sup>	100	0.23	93.3	0.77	93.3	1.99	66.6	2.24	60.0	3.29
Aluminum Foil (coated) (Thin gauge)	R.T. <sup>2</sup>	100	0.24	100	0.28	100	0.31	100	0.50	100	0.59
	45°F	100	0.23	100	0.28	100	0.31	100	0.50	100	0.59
	45°F-RT <sup>3</sup>	100	0.24	86.6	8.91	86.6	16.32	60.0	19.57	0	23.73
Cellophane Exp. Film No. 146	R.T. <sup>2</sup>	100	0.83	100	1.70	100	2.45	100	4.13	100	4.56
	45°F	100	0.83	100	1.70	100	2.45	100	4.13	100	4.56
	45°F-RT <sup>3</sup>	100	1.09	86.6	3.44	66.6	6.51	53.3	7.49	53.3	10.16
Sylphwrap 330 ga	R.T. <sup>2</sup>	100	0.31	100	0.75	100	1.23	100	2.18	100	2.60
	45°F	100	0.31	100	0.75	100	1.23	100	2.18	100	2.60
	45°F-RT <sup>3</sup>	100	0.40	100	2.28	86.6	3.20	80.0	4.14	73.3	6.40
Cellophane 300 ga	R.T. <sup>2</sup>	100	0.07	100	0.36	100	0.70	100	1.15	100	1.43
	45°F	100	0.07	100	0.36	100	0.70	100	1.15	100	1.43
	45°F-RT <sup>3</sup>	100	1.46	93.3	4.79	66.6	8.73	66.6	10.17	66.6	13.38
Sylphwrap 300 ga	R.T. <sup>2</sup>	100	0.41	100	0.69	100	1.04	100	1.86	100	1.92
	45°F	100	0.41	100	0.69	100	1.04	100	1.86	100	1.92
	45°F-RT <sup>3</sup>	100	0.99	100	2.82	86.6	5.22	86.6	6.73	73.3	9.23
Phlofilm 75 ga F.F.	R.T. <sup>2</sup>	100	0.30	100	0.56	100	0.86	100	1.39	100	1.54
	45°F	100	0.30	100	0.56	100	0.86	100	1.39	100	1.54
	45°F-RT <sup>3</sup>	100	1.78	100	6.23	93.3	10.33	93.3	12.78	80.0	16.28
Phlofilm 20 ga P 9	R.T. <sup>2</sup>	100	0.81	100	1.35	100	1.83	100	3.02	100	3.37
	45°F	100	0.81	100	1.35	100	1.83	100	3.02	100	3.37
	45°F-RT <sup>3</sup>	100	1.73	93.3	6.06	80.0	10.40	73.3	13.04	73.3	16.81
Vitafilm 20 ga P.5.	R.T. <sup>2</sup>	100	0.64	100	1.44	100	1.54	100	2.62	100	3.05
	45°F	100	0.64	100	1.44	100	1.54	100	2.62	100	3.05
	45°F-RT <sup>3</sup>	100	1.74	80.0	5.97	80.0	10.31	73.3	12.47	73.3	15.82
Vynlite 20 ga P9V (chem. treated)	R.T. <sup>2</sup>	100	0.64	100	1.30	100	1.74	100	2.87	100	3.30
	45°F	100	0.64	100	1.30	100	1.74	100	2.87	100	3.30
	45°F-RT <sup>3</sup>	100	1.74	80.0	5.97	80.0	10.31	73.3	12.47	73.3	15.82

<sup>1</sup> M.F.—Marketable Fruit. <sup>2</sup> R.T.—Room Temperature (65-75°F). <sup>3</sup> 45°F-RT—Fruit held 4 weeks at 45°F, then removed to R.T. (65-75°F).

TABLE II  
EFFECT OF VARIOUS WRAPPING MATERIALS AND TEMPERATURES ON THE KEEPING QUALITY OF PERSIAN LIMES HARVESTED DURING SUMMER MONTHS

WRAPPING MATERIAL	STORAGE TEMP.	AFTER 1 week		AFTER 2 weeks		AFTER 3 weeks		AFTER 4 weeks		AFTER 5 weeks		AFTER 6 weeks	
		M.F. <sup>1</sup> % WT. loss	% WT.	M.F. <sup>1</sup> % WT. loss	% WT.	M.F. <sup>1</sup> % WT. loss	% WT.	M.F. <sup>1</sup> % WT. loss	% WT.	M.F. <sup>1</sup> % WT. loss	% WT.	M.F. <sup>1</sup> % WT. loss	% WT.
Vynlite 20 ga	R.T. <sup>2</sup>	93.3	3.19	73.3	5.96	60.0	9.95	26.6	11.52	0	13.60	0	0
P9V 3% tri-oxymethyl borate	45°F.	100	0.76	100	1.27	100	2.06	100	2.72	85.7	3.08	85.7	3.58
	45°F-RT					100	3.97	100	5.88	100	9.02	26.6	11.82
Phofilm 75 ga	R.T. <sup>2</sup>	100	2.04	93.3	3.43	73.3	5.32	60.0	6.30	60.0	8.01	46.6	9.64
N.F.	45°F.	100	0.36	100	0.75	100	1.26	100	1.56	100	1.75	100	2.37
	45°F-RT					100	2.55	57.1	3.91	42.8	6.29	42.8	7.81
Lumarth 100P-912 (Cellulose Acetate)	R.T. <sup>2</sup>	93.3	7.95	60.0	13.03	0	17.61	0	—	0	—	0	—
	45°F.	100	2.20	100	3.98	100	5.83	100	7.98	87.5	8.94	50.0	10.64
	45°F-RT					100	10.65	0	—	0	—	0	—
Sylphwrap PB 6 DS	R.T. <sup>2</sup>	100	3.64	100	6.82	66.6	10.32	53.3	12.52	0	14.96	0	—
	45°F.	100	0.61	100	1.35	87.5	1.87	87.5	2.63	62.5	3.05	62.5	3.73
	45°F-RT					100	5.28	57.1	—	0	14.65	0	—
Cellophane 200 ga (Exp. Film No. 149)	R.T. <sup>2</sup>	93.3	6.04	73.3	10.98	33.3	15.57	0	16.31	0	—	0	—
	45°F.	100	1.01	100	2.00	100	3.21	100	4.37	100	5.01	100	5.84
	45°F-RT					100	7.48	85.7	11.01	0	—	0	15.80
Check (no wrapper)	R.T. <sup>2</sup>	100	8.63	73.3	14.69	0	7.73	0	10.55	37.5	11.89	0	13.71
	45°F.	100	2.80	100	4.06	85.7	12.49	0	25.46	0	—	0	—
	45°F-RT					100	2.55	100	9.69	0	—	0	—
Vynlite 20 ga P9V (chem. treated)	R.T. <sup>2</sup>	93.3	3.42	86.6	5.65	53.3	8.36	40.0	9.69	0	11.71	0	13.03
	45°F.	100	0.99	100	1.82	100	2.55	100	4.17	100	4.17	75.0	5.96
	45°F-RT					100	5.21	57.1	—	0	11.13	0	—
Phofilm 20 ga N 1.	R.T. <sup>2</sup>	86.6	1.39	86.6	2.69	80.0	4.80	73.3	5.82	33.3	7.82	20.0	10.09
	45°F.	100	0.29	100	0.56	100	0.78	100	1.17	100	1.40	100	1.58
	45°F-RT					100	1.91	85.7	2.98	42.8	5.03	28.5	6.66
Vynlite 20 ga P9V (Dowicide 6 3%)	R.T. <sup>2</sup>	100	3.17	80.0	5.98	60.0	9.89	46.6	11.44	0	13.74	0	—
	45°F.	100	0.71	100	1.28	100	2.02	100	—	87.5	3.28	87.5	3.71
	45°F-RT					100	4.30	71.4	—	14.2	10.02	14.2	12.73
Vynlite N2 20 ga (chem. treated)	R.T. <sup>2</sup>	100	3.75	73.3	7.17	53.3	11.68	0	13.95	0	—	0	—
	45°F.	100	0.74	100	1.43	100	2.21	100	—	100	3.63	87.5	4.26
	45°F-RT					100	4.58	100	—	14.2	10.97	0	13.96
Vynlite 20 ga P9V (Lead Stearate)	R.T. <sup>2</sup>	100	3.63	80.0	6.07	46.6	9.27	20.0	10.69	0	12.32	0	14.31
	45°F.	100	0.83	100	1.74	100	2.59	100	—	87.5	4.24	75.0	4.86
	45°F-RT					100	5.37	85.7	—	57.1	10.88	42.8	13.84

<sup>1</sup> M.F.—%, Marketable Fruit. <sup>2</sup> R.T.—Room Temperature (80-90°F.). 45°F-RT—Fruit held 2 weeks at 45°F then removed to R.T. (80-90°F.).

TABLE II—Continued  
EFFECT OF VARIOUS WRAPPING MATERIALS AND TEMPERATURES ON THE KEEPING QUALITY OF PERSIAN LIMES HARVESTED DURING  
SUMMER MONTHS

WRAPPING MATERIAL	STORAGE TEMP.	AFTER 1 week M.F., % WT. loss	AFTER 2 weeks M.F., % WT. loss	AFTER 3 weeks M.F., % WT. loss	AFTER 4 weeks M.F., % WT. loss	AFTER 5 weeks M.F., % WT. loss	AFTER 6 weeks M.F., % WT. loss
Phlofilm 100 ga N. 1.	R.T. <sup>2</sup> 45 F. 45 F.-RT	60.0 100 100	0.71 46.6 1.61 0.34	75.0 100 100	2.65 40.0 3.25 62.5 1.25 57.1	40.0 42.7 50.0 0.75 42.8 2.66	33.3 5.30 50.0 0.75 50.0 3.41
Aluminum Foil (Thin gauge)	R.T. <sup>2</sup> 45 F. 45 F.-RT	100 100 100	0.67 0.22 100	73.3 100 100	2.39 0.53 100	9.28 100 100	2.33 0 100
Cellophane Exp. Film No. 146	R.T. <sup>2</sup> 45 F. 45 F.-RT	93.3 100 100	6.78 1.75 100	66.6 100 100	12.07 2.87 85.7	18.19 4.12 85.7	0 100 100
Solophwrap PNB 6 CSX 300 ga.	R.T. <sup>2</sup> 45 F. 45 F.-RT	86.6 100 100	2.33 0.67 100	66.6 100 100	4.46 1.30 100	6.92 2.50 85.7	12.42 4.02 57.1
Cellophane 300 ga	R.T. <sup>2</sup> 45 F. 45 F.-RT	93.11 100 100	1.11 0.48 100	86.6 100 100	2.71 0.77 100	4.63 1.57 85.7	8.83 2.40 28.5
MSAT 86 300 ga	R.T. <sup>2</sup> 45 F. 45 F.-RT	93.3 100 100	3.81 0.81 100	80.0 100 100	7.09 1.37 100	10.78 2.58 85.7	46.6 14.78 100
Solophwrap 300 ga	R.T. <sup>2</sup> 45 F. 45 F.-RT	93.3 100 100	1.85 0.52 100	93.3 100 100	3.91 0.89 100	6.16 1.48 85.7	73.3 100 100
DO627PDS 75 ga F. F.	R.T. <sup>2</sup> 45 F. 45 F.-RT	93.3 100 100	1.53 1.07 100	86.6 100 100	6.56 1.72 100	10.38 2.77 85.7	46.6 75.0 100
Phlofilm 20 ga P. 9	R.T. <sup>2</sup> 45 F. 45 F.-RT	73.3 100 100	3.94 1.08 100	66.6 100 100	7.29 1.76 100	11.47 2.85 85.7	33.3 100 100
Vitalfilm 20 ga P. 5.	R.T. <sup>2</sup> 45 F. 45 F.-RT	73.3 100 100	3.15 1.28 100	73.3 100 100	6.30 1.93 100	9.73 3.11 85.7	46.6 10.05 100
Vynlite 20 ga P9V. (Lead Stearate)	R.T. <sup>2</sup> 45 F. 45 F.-RT	100 100 100	0.80 0.19 100	86.6 93.3 100	1.70 0.51 100	60.0 93.3 100	33.3 93.3 100
Aluminum Foil (Heavy Gauge)	R.T. <sup>2</sup> 45 F. 45 F.-RT	100 100 100	0.80 0.19 100	86.6 93.3 100	1.70 0.51 100	60.0 93.3 100	33.3 93.3 100

M.F., % Marketable Fruit. - R.T., Room Temperature (80-90° F.). 45 F.-RT—Fruit held 2 weeks at 45° F then removed to R.T. (80-90° F.).

which resulted in higher percentage loss from decay, shriveling, and case hardening.

The experiments showed that it is possible to extend the storage life and shelf life of Persian limes with several kinds of wrapping materials and with refrigeration temperature of 45° F. Many of the films showed advantages when used in refrigerated temperatures but were not of value when removed to room temperatures from refrigeration, whereas others were found beneficial under both conditions of storage.

Refrigeration itself proved to be very valuable for extending the period of marketability of limes, the results indicating that the whole lime industry

could be improved by use of more refrigeration, both in transportation and in holding fruit in storage to stabilize the market at times of overshipment. The results also show that a much more valuable consumer type package could be made of any one of several different wrapping materials proven of value in these experiments for preserving better quality of Florida Persian limes than the window-type package which is generally used at the present time and has no moistureproofness.

Not only will further investigations be made as new wrapping materials become available but will also include different types of consumer packages as well as the over-all carton or container.

## THE MANGO RELATIVES OF COCHIN CHINA; —THOSE WITH FIVE-STAMEN FLOWERS

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Plant introduction is a long drawn-out game in which there are critical moments, as I suppose there are in all life. I am reminded of this as I attempt to put down here the incidents which have led up to the writing of this paper.

The Messagerie Maritime boat that I boarded in Bombay in the spring of 1902 made a call of 24 hours in the port of Saigon, capital of the French colony of Cochin China. Twenty-four hours is a pretty short time to explore a country like Cochin China, but I was hurrying through to Japan to meet my patron, Barbour Lathrop.

It was the 16th of April when I got off the boat in the early morning and

made my way to the Botanic Garden in Saigon where, as though he had been awaiting me, I found Dr. Haffner, one of those delightful French botanists who in those days were stationed in the French Colonies, and were in charge of pretty much all the agricultural work that was going on in them. We "hit it off" at once, for he was interested in bringing new crops into the colonies, and when he discovered I could speak French, he told me how he was intriguing the Annamites into growing Javanese peanuts, that were better than their own, merely by *forbidding* any from being taken from his experimental plantings.

When I asked about mangos, Dr. Haffner said I could find in the market a mango which he called the "Cambodiana" which came practically true to seed;

it was planted everywhere and never grafted. There was no time to be lost for my boat was sailing the next morning, so I drove to the market and bought every one of the mangos I could find there. I hadn't even time to return and bid Dr. Haffner adieu, for the job of cleaning the seeds and packing them for shipment took a half dozen "boys" from the hotel and me all the afternoon, and I had just time to get aboard the next morning with the box. The seeds were well packed and arrived by freight 5 weeks later in Washington and were entered in the S. P. I. Inventory as 8701. As I was cleaning the seeds I noticed there was some variation in the fruits, but that, judging from seedlings I had seen elsewhere, it seemed to be a "surprisingly constant variety." The seeds were polyembryonic.

In the strange language of the Annamites they were known as Xoai Voi. This variety or its seedlings have come to be known as the Saigon in the mango region of south Florida, and there are various varieties of it known. Many of my friends prefer its somewhat acid flavor to that of the rich Indian mangos, such as the Alphonse or the Borsha.

I have often regretted that my stay with Dr. Haffner had been so short, for he had such a fund of information about tropical plants.

This spring during the best flowering I have ever had on my mangos, I spent some time examining the flower-clusters. I was tempted to count the amazing number of flowers which compose a single inflorescence, but after counting about a thousand I decided to estimate the number instead. Ten thousand would not be an exaggeration I presume, counting the flowers with pistil and single stamen and those with only the

stamen, with no sign of pistil. It can scarcely escape attention that even if only a few of this great number set fruit, and if each inflorescence bears but 2 mature fruits, you would still have a good crop. But I could not help wondering what might be the result if some plant breeder had at his disposal some close relatives of the mango to cross with it.

I remember seeing a Flora of Cochin China with carefully drawn plates and among them some of the mango flowers with 5 large, well developed stamens. As I examined with my hand lens the mango blossoms on all of my 20-odd varieties and found always a single, more or less well developed stamen and some staminodia, occasionally almost as large as the stamen, my mind reverted to those drawings and I determined to have another look at them.

It so happened that this summer I stayed in Cambridge quite near the Gray Herbarium so I walked over to see if I could find that Flora.

Hoping to find my old friend Dr. Fernald there, although he had retired, I slipped a couple of my best mango fruits in my pocket, thinking they would serve as an introduction to my subject. As I had half expected, there was the great botanist just where I had seen him several years ago; at his desk, with 2 herbarium sheets before him. He was deciding a question of whether two of the American violets were identical or not;—measuring carefully each dimension of the dried leaves, the flower peduncles, etc.

As he looked up and recognized me I laid on the table before him my two mangos, without saying what they were. He looked at them carefully and then said:

"They are not apples, but I never saw them before. What are they?"

"Well, Professor" I said, "they are specimens of a fruit which is eaten by more millions of people than is the apple. They are mangos from my trees in Florida."

I was not shocked to discover that he did not know the mango, for his years of the closest concentration have been spent in a critical examination of the thousands of species of wild plants which compose the flora of the Central and North Eastern States and adjacent Canada. He had been associated with the late Professor B. L. Robinson in the preparation of Gray's *New Manual of Botany* which was published 40 years ago, and has been used by perhaps a hundred thousand of our American youth; and now he is finishing an enlarged new edition. I was once severely criticized by Mr. Lathrop for not knowing who was the golf champion about whom the Washington Star was running headlines, so how could I expect Fernald to know that while he was working on the Manual I had been helping to establish a mango industry in southern Florida.

"I will try them," he said, and we turned to the subject of my visit; a look at the Flora of Cochin China. I thought I remembered just where on the shelf the volume was which I had seen years before, but discovered that I could not recall the author's name. It was not until the professor's library assistant arrived and explained that she had moved the big volumes that we located it: Pierre's Forest Flora of Cochin China.<sup>1</sup>

I opened it at the chapter on the

Anacardiaceae. As I poured over the remarkable plates, drawn by E. Delpy on stone half a century ago, a consciousness came over me of the tragedy, so to say, of my having been in Saigon where relatives of the mango were growing, without bringing any of them home. They should long ago have formed part of the equipment of our mango investigations in south Florida. We have for almost 50 years been planting any old seeds we could get and grafting them with mangos, imported sorts or seedlings originating in our yards, without stopping to consider that all of the varieties had flowers with only one feebly developed stamen, and with root systems which were rather slow to "take hold" in our rocky soils and ill-adapted to the muck soils at our disposal. We had overlooked the possibilities which may lie in these Cochin China relatives, possibilities that they might cross with our mango varieties and give us new hybrids with increased vigor and better pollinating qualities. Five stamens instead of one, and a different root system—a better stock.

We have done just what the citrus growers have so generally done, stuck to one or two stocks, the sour orange or the rough lemon in their case, without exhaustively studying the root systems of the relatives which are scattered over the globe.

With the idea of encouraging, even now after all these years, a field study of these Cochin China species of *Mangifera*, I set up my Rolliflex and photographed the plates of the mango relatives. I have the pictures before me and shall try to abstract the important features of these species. Perhaps some horticulturist may be encouraged to visit this home of the *Mangifera* and related

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<sup>1</sup> Pierre, L. Directeur du Jardin Botanique de Saigon. Flore Forestiere de la Cochinchine. Ouvrage Publie au les Auspices di Ministère de la Marine et des Colonies. Paris, Octave doin, Editeur, 8 Place de l'Odeon. 26 fasciles 1879-1907.

genera and get seeds for experiment of the ones he deems worthy of bringing into our experimental collections.

It would hardly be worth while for this purpose to repeat the technical descriptions of the species which Engler and others gave from their dried specimens, especially since in most cases they did not have the fruits before them. I shall therefore give the habitats of the more promising species, judging from Delpy's careful drawings, and put this rather detailed information into an appendix.

There are five species of *Mangifera* having five distinct, perfect stamens and sometimes additional staminodia. They constitute the section *Euantherae*.

Of the second section which he calls *Amba* Marchand, none of the flowers have more than a single perfect stamen, although some have staminodia which approach in size the perfect stamen, but do not produce pollen. With this section we are not much concerned here, although of course there may be species in it which should be studied. I give in the appendix the complete list, with their habitats so far as I am able to find them in my cursory study of the Flora. The native names are given when available, and were I where I could study the literature thoroughly, I might find more data. I am struck with the meager material which seems to have been at the disposal of the various authors, who had not been able to see the fruits and were obliged to take hearsay information.

I am not sure how valuable will be these attempts of mine to point out the characters of the various species from a study of the very crowded lithographic plates by Delpy. If they serve only to emphasize how important it would seem that a careful, modern study of this

genus *Mangifera* be made on the spot where it occurs, they have served a purpose. Photostats of these plates are in Miami University Library.

It is beyond my power to delve into all the various monographs on *Mangifera* and put down all that might be useful to one going out after the seeds for introduction. A mere botanical study of the various species would hardly get us far on our way towards the utilization of the mango material out of which new and perhaps superb and valuable varieties could be produced.

I cannot refrain from mentioning in closing this paper, that in this Flora by Pierre there are pictured a number of other fruits which should long ago have been on trial in south Florida.

*Swintonia pierrei*, Hance and *Bouea burmanica*, Griff might be especially mentioned. A good half plate is given of the former which is called "Soari" by the native Kners, and shows fruits resembling those of the mango. The Radja of Soija once showed me an orchard of the *Bouea* in Amboina, where they call it the "Gandaria." Dr. Ochse, who had pictured it in color in his "Fruits and Fruit Culture in the Dutch East Indies" is very enthusiastic and has pointed out that there are many varieties of it in West Java. Whether this *Bouea burmanica* is as good in flavor as *B. macrophylla*, I am not in position to say. Now that Dr. Ochse and his son-in-law, Dr. Dijkmann are connected with the University of Miami and are familiar with the fruit, it may not be long before we are able to try the various varieties.

As I turned the pages of Pierre's Flora and saw the superb plates, I could not but wish that vastly more work had been done in looking up in Tropical Floras, plants suitable for introduction into



Florida. We have barely scratched the surface of this work for the horticulture of this region where so many of us have chosen to spend our lives.

#### APPENDIX

Section 1. EUANTHERAE. Disc short and thick Stamens 5 to 12 of which 5 to 6 are fertile, the others reduced to filaments.

*Mangifera Duperreana*. Stamens 10 to 12 of which 5 to 6 are fertile. Two millimeters long. Between each lobe of the disc there is a filament without an anther either upright or curved. Delpy's figures 14 and 21, Plate 362, A, show clearly the fully developed stamens and between them the sterile filaments. The fruits were unknown to the author but are said to be smaller than those of *Mangifera indica*, fibrous but succulent. The inhabitants of the island of Phu Kwok (Phu Quoc), off the coast of Cambodia, use the timber for oars. In the province of Samrongtong they make boards from the timber.

*Mangifera pentandra*, Hook. f. Fl. Brit. Ind. II 14, figured by Delpy as F. 3 and 5 of Plate 364 as having 5 stamens of more or less equal length, 2 millimeters long, flattened at their bases. Nearly related to *M. Duperreana* and *M. caloneura*, Kurz but with seven distinct nerves on the inside of the petals. Its fruit was not described "mais ne murt pas naturellement. De la son nom malais: "Mam Ploni," according to Mainguay. No exact locality is given for this species. Description taken from Engler, Monog. Phanerog. Vol. IV, 198.

*Mangifera caloneura*, Kurz Fl. Burma I 305 Hook. l. c. p. 14. Engler l.c.p. 200 Petals have three nerves on inside instead of seven as in *M. pentandra*. Stamens 5 subequal in length, 2 millimeters long with an aborted stamen the shape of a horn. Fruit 5 to 6 centimeters, yellow, subacid, slightly kidney-shaped and attenuated above. Species generally distributed from Pegu to the province of Petchapury on the eastern border of Siam.

*Mangifera cochinchinensis*, Engler l.c. 205. Delpy's Fig. 4, Plate 362 B, shows 5 well developed stamens and his figure "1" a flower with unusually long petals each with four dis-

tinct nerves. His Figs. 8, 9, 10, 11, 12 show fruits that appear to be monoembryonic. No text regarding habitat but doubtless Engler's Monograph Phaenerogamorum, Vol. IV, will give this data.

*Mangifera lagenifera*, Griff. Notul IV 414 t. 367 f. 3. Hook l.c. 18. Engler l.c. 211. Delpy's figures C 3 and 4, Plate 365, show a flower with very long petals; 7 mm. long, nearly twice the length of either *M. cochinchinensis* or *M. Duperreana* or *M. pentandra* with four nerves on the inside sometimes reduced to three. There are 5 fertile stamens and 5 staminodia reduced to short lanceolate filaments. The style is longer than the stamens. Fruit pyriform, 1½ decimeter long, and 3.7 centimeters broad. According to Griffiths the fruit is green, smooth, heavy and fetid with secretions "vern'sses," (varnished) black, with flesh very fibrous with an endocarp, ovate lanceolate coriaceous and fibrous. Related to *M. cochinchinensis* and *M. zeylanica* also with *M. foetida* and *M. odorata*. The flower disc is hemispherical as in *M. foetida* var. *Kawinii*. It is also related to *M. superba*. Habitat: the peninsula of Malacca from Muong-Pran east coast to Malacca (I find Meng Pran in the Times Atlas.) *Species with 5 stamens: (Stamens 5 to 12 of which 5 to 6 are fertile, the others reduced to filaments).* Section I.

*Mangifera Duperreana* from Phu Quoc island (Phu Kwok?) off the coast of Cambodia and the Province of Samrongtong.

*Mangifera pentandra*. No exact locality given but the native name is "Mam Plom" according to Mainguay whose writings should be consulted. (Plate 364, Fig. F. 5 shows 5 unequally developed but perfect stamens and a long style.)

*Mangifera caloneura* from Pegu to the province of Petchapury on the Eastern border of Siam. (Plate 364, Fig. G 3 & 5, shows 5 short perfect stamens and strong pistil.)

*Mangifera cochinchinensis*. No habitat given. Consult Engler's Monograph.

*Mangifera lagenifera*, Griff from the peninsula of Malacca, from Muong-Pran on East Coast to Malacca. (Possibly Meng Pran.) *Species with only a single stamen, rarely two*

functional, the others aborted. Or lacking anthers. Always very small when present. Section II.

*Mangifera macrocarpa*, Blume, Bijde. 1158 Engler l.c. 210. *M. fragrans*, Hook. f. l. c. 181. Stamens 5 but all of which are provided with anthers but of which 4 are half length. Fruit according to Mangay 1 decimeter long; according to Blume the size of a child's head. Habitat "la Malaisie, le Cambodge et la peninsule malaise."

*Mangifera longipes*, Griff. Delpy pictures the flower as having a long pedicel in Plate 365, A.

*Mangifera odorata*, Griff. Delpy's drawing shows only 1 stamen but long petals, Plate 365, B.

*Mangifera superba*, Hook. Delpy's figure D, plate 365, shows the flower with very long petals and the fruit perched on a very long pedicel. Related to *M. laginifera* and probably having the same general habitat.

*Mangifera foetida* Lour. var. *Kawinii*, Blume. Delpy shows the flower on a short pedicel and the small petals with 3 pronged inner markings. Plate 365, Fig. E. Two other varieties of this species are shown; F. fig. with very long reflexed petals as variety *Cochinchinensis*. This has 5 well-developed stamens 4 of which may not be functional. Fig. G. shows variety *Blumei* with short stamens only 1 of the 5 being perfectly developed.

*Mangifera indica* L. var. *Compressa*, Blume. Delpy's Fig. "a" plate 361 small figure 6 shows a very short pistil, 1 perfect stamen and various lengthed staminodia and a multiembryonic seed.

*Mangifera indica* var. *Cambodiana*. Delpy shows Plate 361, Fig. B. sessile flowers with short petals and a single stamen with various aborted staminodia, an obliquely set pistil with long style and a polyembryonic seed. Data regarding the habitat of both these varieties I have not secured. Presumably they are native of Cambodia.

*Mangifera laurina*, Blume, is figured in Plate 364, Figs. A, 3 and 5, as having small sessile

flowers with a very small short pistil and only 1 short stamen with mature anther and very small staminodia.

*Mangifera sylvatica*? Roxb. on Plate 364, Fig. B, as having diminutive pistil shorter than the single stamen and with several staminodia.

*Mangifera khasiana* on Plate 364 Fig. C, shows flower with long petals and 1 long pistil, longer than the single stamen, apparently monoembryonic.

*Mangifera altissima*, Blanco. On Plate 364, Fig. 5, is shown an extremely small flower with very short petals and a pistil with style very short and robust and curved towards the single short stamen; staminodia sessile and with no signs of filaments.

*Mangifera quadrifida*, Jack, has, according to Plate 364, Fig. 11. 3, 4, 5, very small flower with stunted pistil, style curved towards the single stamen and staminodia short without partially developed filaments.

*Mangifera oblongifolia*, Hook. f. Plate 364, 1, 3 and 5, show flower with long petals, long robust pistil with staminodia having partly developed anthers.

*Mangifera zeylanica*, Hook. f. Plate 364, Fig. 3 and 6, show flower with long petals reflexed, a tall disc and one well-developed stamen, several sterile filaments.

*Mangifera griffithii*, Hook. f. Plate 364, Fig. K, 3 and 4, show very short pistil and very short stamen, the pistil curved over the stamen and the disc strongly developed. Petals short and flower small.

*Mangifera microphylla*, Griff. Plate 364 L 3 and 5 show pistil with long style and single well developed stamen and several small staminodia.

*Mangifera caesia*, Jack. Plate 364 M 3 and 4 and 5 show very long petals and long style and rather obscurely, short staminodia at the base of longish disc. In unusual length of petals approaches *M. kemanga*, Blume.

*Mangifera kemanga*, Blume, Plate 364, Fig. N 4, 6, 10, depicts flower with unusually long slender petals and pistil with style five times as long as the diameter of the basal ovary.

# A RAPID METHOD OF PROPAGATING THE GUAVA

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The common guava usually is propagated by seed but seedlings cannot be relied upon to produce fruit identical with that of the parent tree. Choice varieties can be increased only by some vegetative means of propagation.

Varieties are rather difficult to propagate by the usual vegetative methods employed for other fruits. Shield and patch budding and side-veneer grafting

are possible on young stock plants but it is difficult to obtain a high percentage to live. These methods are also rather slow, since a period of 2 to 3 years is necessary from the time seed is planted to produce a salable tree. Furthermore, guavas are grown in many areas in Florida where the trees are liable to be frozen to the ground occasionally. It is desirable to have both the root system and top of the desired variety to avoid its loss from freezing.

Fairly large trees may be crown-bark or cleft-grafted but usually the tree per-



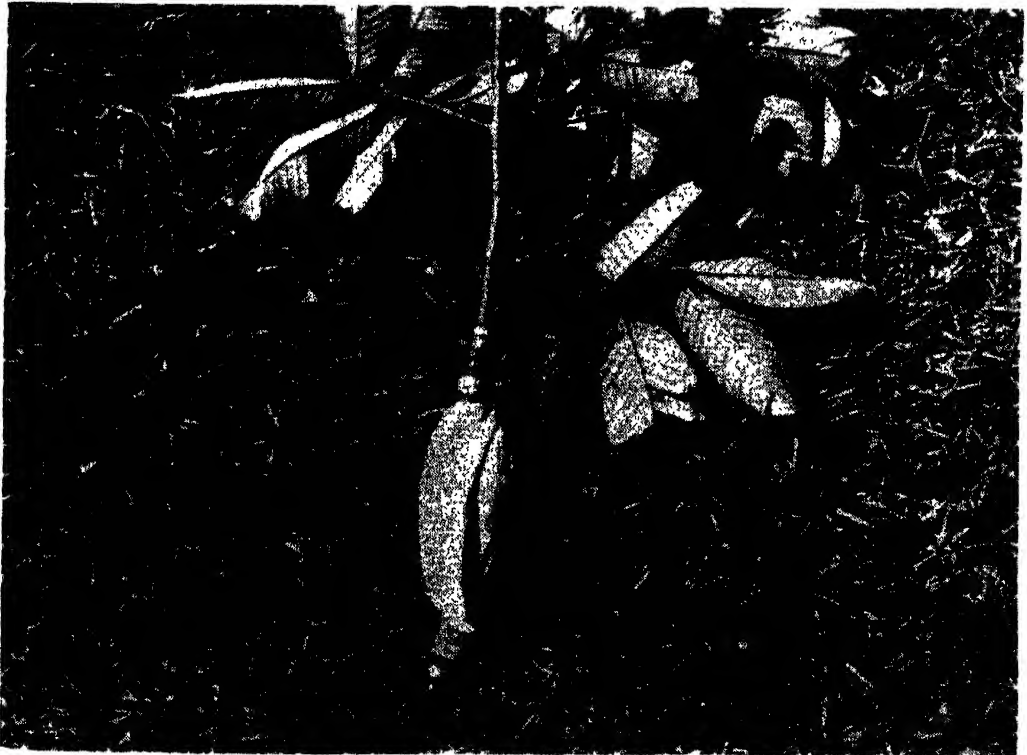
*Fig. 1. Air-layering from bearing guava tree.*

sists in suckering below the graft union and a severe freeze may cause the loss of the desired variety. Root cuttings will often grow with fair success. Mowry (3) reported 70 percent success with root cuttings planted during November. Webber (4) recommended root cuttings as the easiest method of propagating superior guava varieties in California.

Another method of making a limited number of plants unless the parent tree has been produced by graftage, is to sever roots 2 or 3 feet away from the trunk with a spade or mattock and after sprouts develop from the severed portions, to transplant them, disturbing the roots as little as possible. Some success

has also attended attempts to root stem cuttings and Cooper and Knowlton (1) reported a higher percentage of rooted cuttings and a greater number of roots per cutting when the basal ends were treated with hormones. These methods are rather slow, however, and require considerable work and close attention to details for success.

It has been known for years that the guava can be air-layered successfully by the ancient method employed by the Chinese for propagating the lychee, but the expense of watering the soil or moss used as rooting medium is a serious drawback to the method. An improved method of air-layering recently described

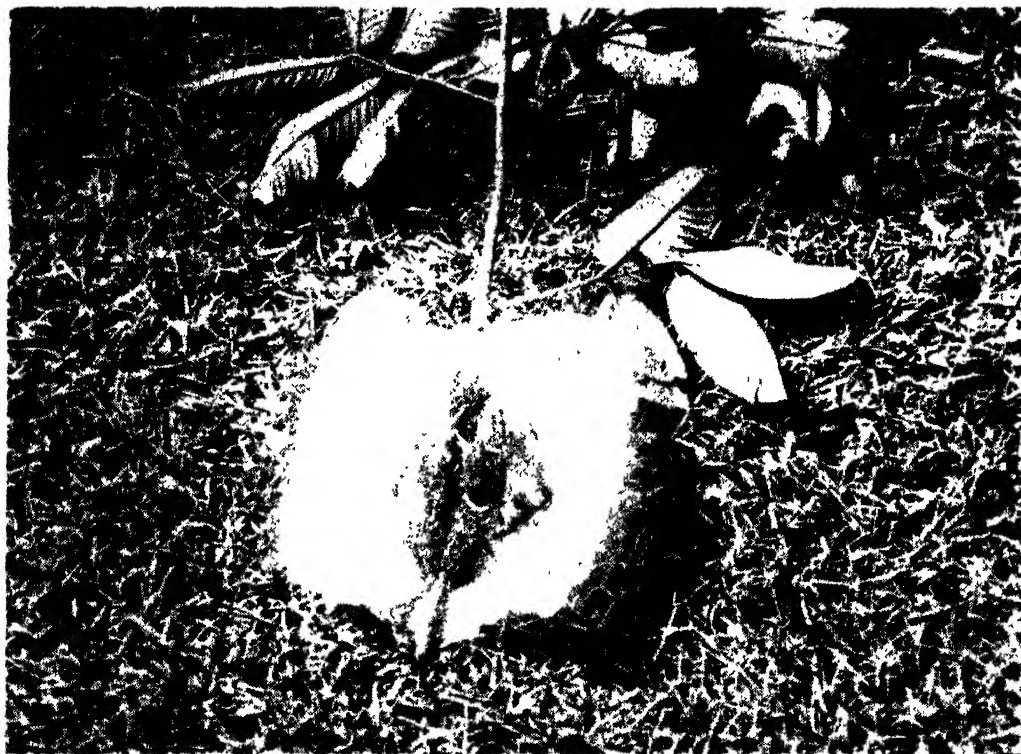


*Fig. 2. Layered branch removed from parent tree after roots appear under plastic wrapper.*

by Grove (2) for rooting lychee and other trees has proved to be an excellent method for propagating the guava.

The method is quite rapid and is relatively simple. Limbs of one-half inch or more in diameter are girdled by removing a strip of bark about one and one-half times the width of the limb. The girdled area is bound with a ball of moistened sphagnum several inches in diameter and 4 to 5 inches long, which is then wrapped with a sheet of heavy grade of translucent rubber plastic film (Vitalon) and tied securely at each end with rubber bands or string (Fig. 2). A piece of newspaper or wrapping paper tied loosely over the wrap (Fig. 1) pre-

vents birds from picking holes through the plastic and also prevents the moistened moss from overheating from the sun's rays directly striking the plastic. The plastic film allows passage of respiratory gases but retains moisture. The wrap is left attached until sufficient roots can be observed through the plastic. Usually they begin to form in 3 to 5 weeks. If they do not begin to show after 6 weeks, the wrap should be removed and the girdled area examined. In some instances callous grows over the girdled area before root development begins. Re-girdling and re-wrapping usually is followed by root formation in a few weeks.



*Fig. 3. Roots running through sphagnum ball at time of removal of layered branch.*



Fig. 4. Layered branch headed back and planted in soil in tar-paper cylinder.

As soon as roots grow through the ball of moss, the stem may be severed below the girdled area. The plastic is then removed (Fig. 3), some of the top is headed back (Fig. 4), and the new tree is planted in soil in a plant container of sufficient size and placed in a shady place until new foliage is produced. The soil is then given a light application of a fertilizer mixture of low analysis and the foliage is sprayed with a nutritional spray containing copper, zinc and manganese. When the new twigs are 6 to 8 inches or more in length the tree is ready for hardening in full sunlight in preparation for planting in the field (Fig. 5).

Trees can be made in 4 to 5 months at relatively low cost by this method. The



Fig. 5. Layered tree 5 months from the time the branch was girdled and the girdled area wrapped. It has been hardened off and is ready for planting in the field.

cost of materials is but a few cents per tree and labor cost is low because the expense of watering is eliminated. Guava trees have been made at the Florida Subtropical Experiment Station during the past 2 years with close to 100 percent success by this method. The few failures which have occurred were the result of breakage by hurricane winds or from birds pecking holes in the plastic film. It probably is advisable to prepare the layers in Florida before July 1, to be certain that they can be removed before the height of the hurricane season.

The method should prove adaptable for nurseries. The plastic film used thus far is manufactured by the Goodyear Tire and Rubber Company and is now available in small or large quantities. It

is probable that rubber plastic films manufactured by other firms will prove equally satisfactory.

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## HEILIPUS SQUAMOSUS Lec., A NEW ENEMY OF THE AVOCADO

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This insect problem was recognized about 1 year ago. In October of 1947 a boring insect was discovered in a young avocado planting of the Sunland Groves where it was injuring and even killing the trees. Between 8 and 10 percent of the trees were counted as losses in a block of 512 trees. Larvae were sent to the Division of Insect Identification, U.S. Bureau of Entomology and Plant Quarantine, which Dr. W. H. Anderson tentatively identified as *Heilipus squamosus* Lec. Examinations of trees in other plantings showed that the insect was commonly present in southern Florida. Larvae in stumps of infested trees were reared to adult emergence. These adults were submitted to Mr. L. L. Buchanan of the Division of Insect Identification who confirmed Dr. Anderson's previous tentative determination made from the larvae.

The insect must have been present, infesting avocado trees in south Florida for several years. Dr. George D. Ruehle

reports that such an insect was found some 8 to 10 years ago in trees at the Subtropical Experiment Station. A photographic slide in Station files made about 1939 identified by the title, "Boring grub on avocado trunk," illustrates signs recognized as those of *Heilipus squamosus* Lec. Knives were used to cut out and destroy the larvae in the infested trees at that time. Grove owners and caretakers now report having seen the same or a similar insect in avocados for several years. It cannot be said with certainty whether the present infestations may be an annual occurrence, or an unusually high one attributable in part to trees that had been weakened or injured by wind or high water.

*Heilipus squamosus* Lec. is a beetle, a member of the snout weevil, Curculionidae family. Some of these weevils are serious pests on other crop plants. Three examples are the cotton boll weevil *Anthonomus grandis* (Boh.), white-fringed beetle, *Pantomorus leucoloma* (Boh.), and plum curculio, *Conotrachelus nenuphar* (Herbst.). Close relatives of *H. squamosus*, however are recognized as insects attacking the avo-

cado in other areas. Four of these recognized in Central America are *H. pittieri* (Barber), *H. trifasciatus* F., *H. lauri* (Boh.), and *C. Perseae* (Barber). Responsibility for preventing entry of these insects into the United States is invested in our quarantine officials. None of the four avocado pests listed above, nor of *H. squamosus* is listed in a Catalogue of Cuban Insects, by Bruner, et al (1945). No records are known of either of these avocado insects having been taken in the West Indies Islands.

*Heilipus squamosus* has been taken, according to Dr. W. H. Anderson, (correspondence) on cotton, sassafras, and Satsuma orange. It has also been taken on pine, according to Blatchley and Leng (1916). It has been taken in Florida, Georgia, and Tennessee in the United States, also in French Guiana, according to Blatchley and Leng (1916). The evidence indicates, therefore, that it is a native insect. Although the insect has been taken from plants other than the avocado, and it must have other host plants, the biology of the species remains practically unknown.

In view of the present problem a need for a common name for the species has arisen. It is a bark weevil and might be termed the "avocado bark weevil." Since it is the habit of the beetle larvae to burrow in the bark at the base of the trees the species might be termed the "avocado collar weevil," or "avocado collar borer." The term "avocado crown borer" has also been suggested since the larvae burrow at the juncture of root and stem parts of the plant. The damage caused by the insect, however, is through girdling of the trees. It seems, therefore, that from the economic viewpoint the term "avocado tree girdler" is an appropriate term. It is the term herein

proposed as a temporary one until further knowledge indicates the need of a more appropriate one, or until common usage confirms it as a satisfactory term.

The *Heilipus squamosus* (Lec.) adult is characterized by its black color, very irregular white areas and spots on its wing covers, and oblong shape. It is about one-half an inch long. Its beak is slightly longer than its thorax. (Fig. 1).

Eggs are deposited in the edge of the bark usually at ground level. White, slightly yellowish footless grubs or larvae



Fig. 1. *Heilipus squamosus* larva, pupa, and adults. Magnifications—Pupa 3x, larva 3x, adults nearly 3x.



hatch from the eggs. The larvae are small, about one-fourteenth of an inch long at hatching time. As they feed and develop they grow to one-half or five-eighths of an inch in length. Nearly mature larvae are most active in extending their burrows and in pushing grass from the trees. Infestations appear to be most abundant at this time because they are more easily observable.

There seems to be about one generation per year, as Dietz and Barber (1920) reported for *Heilipus perseae* Barber. Many adults have been observed in April, May, and June although adults and other stages may be found occasionally any month of the year. Observations indicate that the longest part of the life cycle is spent as larvae; the next longest as adults, although the average length of time spent in each stage has not been determined. It is likely that the larval stage is the one most adapted to control measures.

Signs of *Heilipus squamosus* infestations are masses of frass exudations at the base of the trees. Fresh signs are reddish in color, but change and become lighter red to pale brown in color. The masses tend to fall apart and be washed away by rains. These signs are nearly always found at or near the soil level, frequently between cracks in the thick bark. The larvae seem to provide an opening in the bark through which they may push the castings, although most of the frass remains in the burrows, behind the larvae.

Symptoms of *Heilipus squamosus* infestations were observed during the months of February and March. These symptoms were yellowing leaves and premature leaf fall. Often a leader or part of a tree expressed symptoms while other parts did not. Examinations of

trees exhibiting these symptoms disclosed that severe injuries or partial girdling had occurred beneath the affected branches. The expression of symptoms by trees this time may be accounted for by (1) voracious feeding activities of large nearly mature larvae, and (2) the dry season, and consequent need of moisture by the trees. These symptoms have been observed only in small trees, those of 3 to 6 inches in diameter at 6 inches above the ground. Other factors may induce these or similar symptoms, hence the symptoms are not a positive means of determining borer infestations.

Most signs of infested trees are observed, and nearly all larvae are taken within 6 inches of ground level of small trees. It is only in large 13 to 24 inch tree bases that they have been found up to 2 feet high in the heavy bark of the trunk, especially in the crotches of trees previously top-worked or storm-damaged where irregular, knotted, or burlled conditions existed.

Although the borer infests both young and old trees, the young trees, 1½ to 4 years old suffer more than the old trees. The older trees seem better able to grow and survive the insect infestations. Younger trees have thinner bark, which is more likely to be completely severed by the feeding larvae. In young trees the larvae usually burrow along the cambium layer and sometimes score deeply into the wood tissues. This, in effect causes partial or complete girdling of the tree, depending on the number of larvae in the tree.

Tree losses vary from grove to grove, as may be expected; losses from zero to 10 percent have been observed. The average loss is probably less than 1 percent. A more detailed study, made in a block of 240 trees almost 2 years old, in

a Subtropical Experiment Station experimental planting is an example that may typify general conditions. One tree was found dead, having been girdled by larvae. Two trees were almost entirely girdled, while another was very severely injured. Almost 9 percent of the trees were found infested with one or more larvae. A total of 40 larvae was removed from 239 trees which averages 0.17 larvae per tree. According to the observations made in these trees, 3 to 6 inches in diameter at 6 inches above soil level, from 5 to 8 larvae per tree may be expected to injure them fatally.

*Fruit Injury.* Although the adults are usually found on the basal portions of the trees engaged in egg deposition, they were also found feeding on young avocado fruits. Hollowed out excavations about one-sixth to one-half inches in diameter and up to one-tenth inches deep are characteristic of the feeding wounds (Fig. 2). The wounds are more pit-like in early stages of beetle feeding, but enlarge by additional feeding. The pit-like wounds are about one-tenth of an inch deep and one-twentieth inch in diameter. Some fruit-drop was observed of badly injured fruit. Most of the fruit remained on the trees and scar tissue grew over the wounds (Fig. 3). Some wounds appeared at harvest time as superficial scars. Other wounds, or numerous wounds on the fruit cause such disfigurement as to classify the fruits in lower grades or as culls. Of the total fruit produced it is desired to emphasize that only a very small portion is injured by *Heilipus squamosus*. This attention to fruit injuries is for information rather than for economic reasons.

*Control.* In the one year this insect has been recognized experiments have

been initiated to develop control measures. Spraying the infestable parts of trees with one or more of the newer insecticides might be expected to give control. Although they are being tested none is now recommended. Manual removal of the larvae is the current recommendation. This necessitates examinations of the trees for signs of infestation and of cutting out the larvae.

There are some enemies of the *Heilipus squamosus*. Birds, apparently of the woodpecker group, eliminate a few larvae. They seem to feed on larvae only in trees which have no weeds or other debris about the tree bases. The birds, furthermore, feed on the larger more mature larvae, hence most of the tree injury has been sustained by the time the birds begin feeding. Although parasitic and predatory insects and other enemies may prey on them only ground beetle larvae have, up to the present, been observed feeding on the larvae in their burrows.

*Summary.* Beetle larvae of the snout weevil family, *Heilipus squamosus* Lec. species were recently recognized injuring and killing avocado trees. This is the principal type of damage of the species, although they were also found feeding on young fruit. Young trees about 2 years old appear more seriously injured than older more mature trees. These larvae burrow in the inner bark, feed, and push out frass as a sign of infestation. One generation per year appears to constitute a life cycle. Examination of each tree and the removal of the larvae by digging them out of the trunk is the recommended control at present. Other control methods are being investigated, which may prove more practical.

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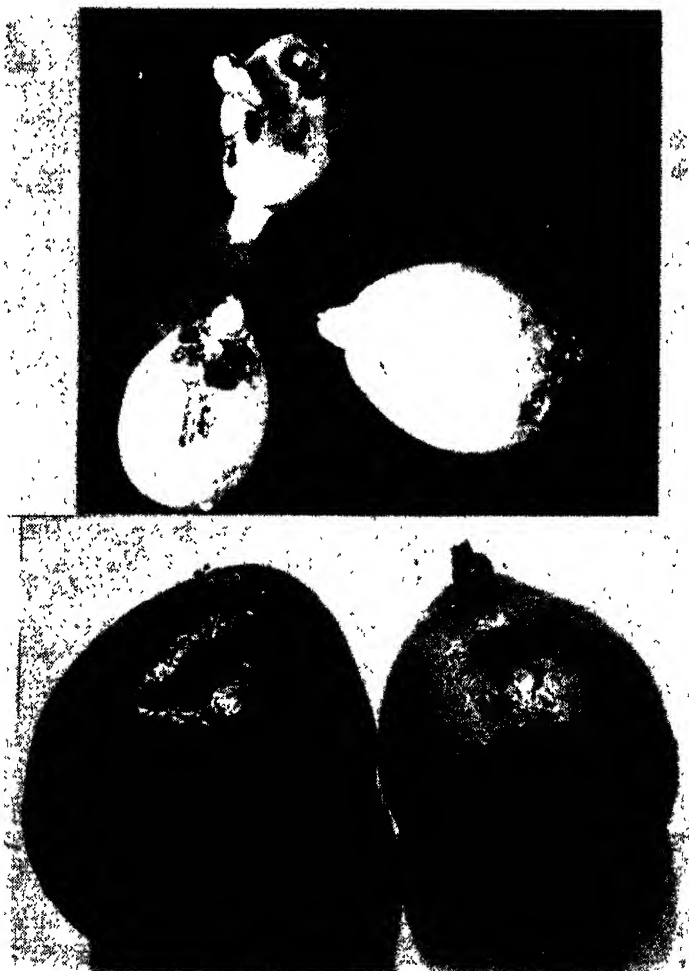


Fig. 2. Avocado fruits injured by *Heilipus squamosus*. Top is young fruit at time of injury (beetle in upper right). Near natural size. Bottom is healed-over scars at picking time. About three-fourths natural size.

# NOTES ON THE GRAFTING OF LITCHI CHINENSIS SONN

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The limited propagation of the Litchi in the United States to date has been primarily accomplished by air-layering, which is also the most common method of propagation used in China for this choice Sapindaceous fruit. A partial review of the literature published on the Litchi indicates that other methods of propagation have been successfully used.

G. Weidman Groff (1) refers to a successful method of propagation by cuttings developed in the greenhouses of the United States Department of Agriculture at Washington, D. C. Groff further states that inarching is often resorted to and that cleft grafting is also practiced by the Chinese.

William F. Cooper (2) et al, reported on the successful rooting of cuttings on the Sweetcliff Litchi by treating leafy cuttings with indoleacetic acid.

In Hawaii, (3) W. T. Pope and Wm. B. Storey report that from 10 percent to 20 percent success may be obtained by side-tongue grafting Litchi seedling nursery stock of from 10 months to 1 year of age.

J. E. Higgins (4) reporting on work done in Hawaii stated that successful grafts were obtained by bark grafting. Higgins further reported that he was able to use this method in grafting the Litchi on longan stock. However it has subsequently been reported that these

intergeneric grafts did not continue to grow on vigorously.

The use of plastic wrappers in the air-layering of *Litchi chinensis* described by Colonel Wm. R. Grove (5) has greatly facilitated this method of propagation.

With large stock plants available, and a reputed ready market for the fruit, it appears that the several nurseries so engaged will continue their propagation of the Litchi using the air-layering method exclusively.

The question is raised as to whether the air-layered Litchi trees of the Brewster, Kwai Mi, and other varieties will prove most suitable for our varied conditions in south Florida or whether different rootstocks would affect the performance of the several varieties of *Litchi chinensis*. It appears desirable to investigate the moisture tolerance, cold resistance, age of bearing, fruitfulness, vegetative vigor, tolerance of soil types of different rootstocks as compared with trees propagated by air-layering or cuttings.

Attempts at grafting *Litchi chinensis* in Florida have been limited. One reason for this being a limited supply of viable seed. Where seed has been available, difficulty has been experienced in growing on vigorous seedlings for use as stock plants.

Frederick V. Coville published on the mycorrhizal nature of *L. chinensis*. He found that ordinary potting-soil mixtures were unsatisfactory for seedling growth while where an acid mixture of 2 parts of peat and 1 of sand was used the seed-

lings grew vigorously. In this acid peat-sand medium the roots developed numerous tubercles filled with a mycorrhizal fungus.

A number of years ago samples of mycorrhizal soil were sent to this Station for incorporation in the soil mixture to be used as a potting mixture for Litchi seedlings with unsatisfactory results. Perhaps the Ph was too high to support the growth of the fungus.

Dr. George D. Ruehle found that healthy vigorous seedlings could be grown by planting fresh viable seed in 6-inch pots of sphagnum moss and feeding these seedlings with a well-balanced nutrient solution. It has not been necessary to inoculate the sphagnum with the mycorrhizal fungi. Examination of the roots of these healthy seedlings shows an abundance of pear-shaped root tubercles similar to those illustrated in Groff's text.

These *Litchi chinensis* seedlings when grown under glass developed a caliper of one-fourth to three-eighth of an inch within 10 to 12 months. Several attempts to graft these seedlings were made with the following results:

No success was had to date with side-veneer grafts.

Approximately one-third of the cleft-grafts attempted were successful when the following technique was used:

The seedling stock plants were removed from their pots with their ball of sphagnum intact. The seedlings were then topped at approximately 1 inch from the surface of the sphagnum. A cleft of one-half to three-fourth inches long was made. Scions of newly formed wood showing developed but unsprung axillary buds having an equal caliper of the stocks were selected. Scions having two nodes which were approximately 2

to 2½ inches long were inserted in the cleft then tied with rubber bands, and all cut areas were covered with grafting wax.

The axillary buds of the successful grafts sprang in about 2 to 3 weeks. It is advised to leave the rubber bands in place for at least 60 days, as premature removal can cause loss of otherwise successful grafts. There is no apparent danger of constriction when the rubber bands are left on for even a longer period.

Inarching a number of the Brewster Litchi scions on *L. chinensis* seedlings was tried with excellent results when the following technique was employed:

The sphagnum grown Litchi seedlings were removed from their pots with the ball of sphagnum intact. The moss ball was thoroughly moistened and then wrapped in a sheet of Vitalon plastic. The low weight and nature of the Vitalon-wrapped moss-cultured seedling permitted it to be secured easily to a corresponding small-calibered branch of the desired scion tree with ordinary wrapping twine. Strips of Vitalon were wrapped over the rubber bands to secure the inarch which was 2 to 3 inches long. The inarched plants were removed 4 weeks later. The Vitalon wraps were removed and the plants replaced in their original sized containers in the greenhouse. There was no need of watering during the 4 weeks the seedlings were attached to the scion tree.

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In the discussion which followed Mr. Cobin's paper, the following letter from Prof. G. W. Groff was read by Wm. R. Grove. Since it deals with lychee propagation, it is included herein.

Laurel, Florida  
October 26, 1948

Dear Colonel Grove:

Through the courtesy of Mr. Cobin I have had the opportunity of reading with interest his paper.

In China layering and inarching lychee are practiced widely. Cleft-grafts upon large, dehorned trees are successfully established if carried out in the damp, cloudy weather of early spring. Experimental work carried out at Lingnan University by A. N. Benemerito, trained under Wester of the Philippines in the art of grafting, resulted in approximately 20 percent success with side-grafts under field conditions. We never

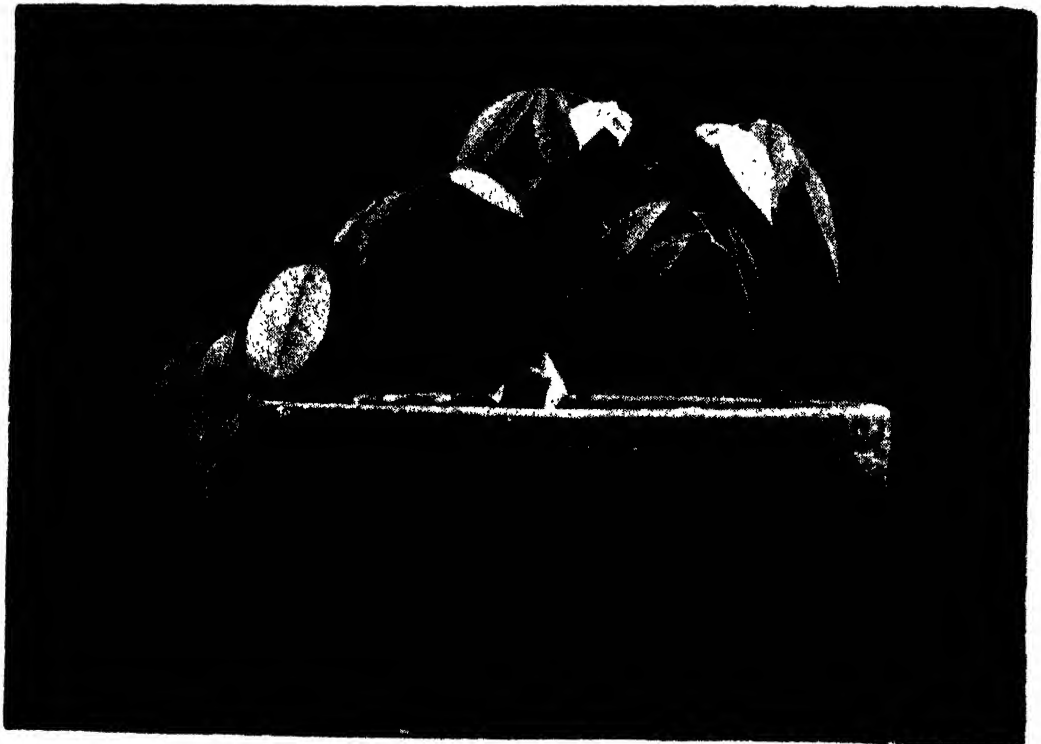


Fig. 1. *Litchi chinensis* Sonn. seedling cleft-grafted with scion wood of Brewster variety.

found a method of successfully grafting or budding lychee seedlings, established in rows under field conditions, as is commonly practiced in the West with Citrus species.

There is apparently something unique in the wood and bark structure of the lychee which lends itself so readily to layering and inarching but so poorly to grafting and budding. Quoting Rendle in *Classification of Flowering Plants*, Vol. 2, page 295, under Sapindaceae, I would like to point out at this time:

"They (namely plants of the Sapindaceae) are trees and shrubs, sometimes lianes climbing by tendrils *and with remarkable stem structure*, the result of anomalous secondary growth in thick-

ness. In addition to the central vascular bundle-system, cortical systems are developed, often showing considerable complication . . ."

A study of the wood structure of the lychee by some qualified plant anatomist might prove of some theoretical, possibly practical value in knowing better how to handle the wood of the lychee in grafting and budding. It should also reveal whether the abnormal wood structure of the lychee is the chief factor in the readiness with which it is air-layered. It might also lend significance to the art of air-layering plants in groups other than the Sapindaceae.

Sincerely,  
G. W. GROFF

## REPORT OF THE SUBTROPICAL FRUIT COMMITTEE

DR. FRANCIS B. LINCOLN  
Homestead

Since the last annual meeting of the Krome Memorial Section, this committee has registered six seedling fruits, these being 3 mangos, 2 avocados and 1 carissa. This report will consist of descriptions and photographs<sup>1</sup> of these several new varieties. The numerals preceeding the variety names are the registration numbers of the respective varieties.

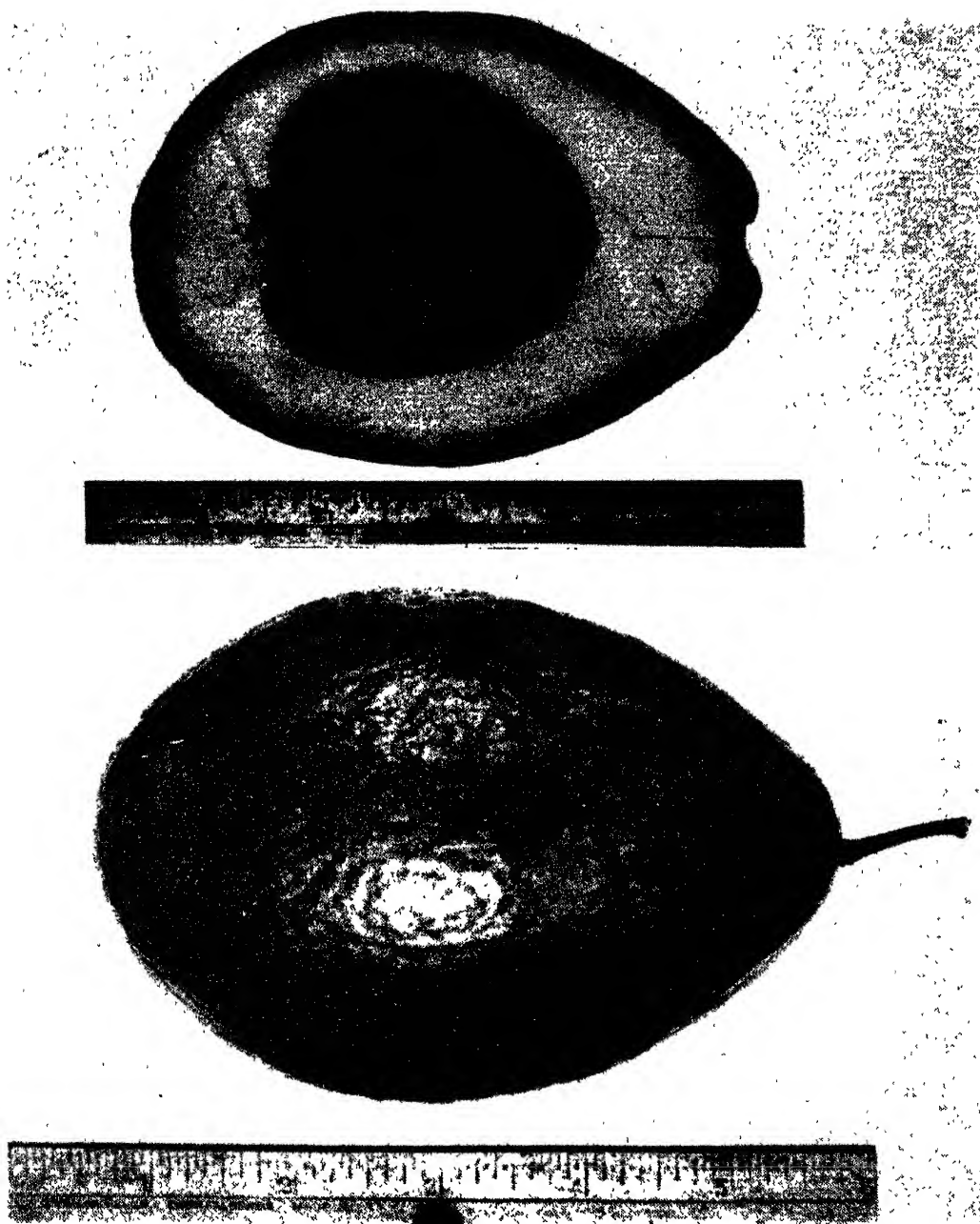
### No. 7. BYARS AVOCADO

Originated on the place of E. C. Byars, Sr., on Redland Road, north of Homestead, Florida as a seedling of Collinson. At present the tree is 16 years old and of good vigor aside from the damage

effected in the 1945 storm. It is reported to have been very productive each year of a late season, fruit maturing from January to April. This clone has been multiplied in Mr. Byars' grove by top working of old trees and the budding of young seedlings.

*Description of fruit.* The elliptical shaped fruit is rather large, olive green in color, with a dull finish. The surface of the skin is slightly rugose and stippled with light green lenticle (Fig. 1). It measures 5½ to 6 inches long by 4½ to 5 inches wide, approaching 2 pounds in weight, 20 percent of which is seed. In some of the fruits the seeds are loose. In the large fruit there was a clean separation of the seed coat from the flesh. The flesh is yellow to the center with a wide green area next to the skin. The texture and flavor are very good with the flavor being very pronounced. *The oil content*

<sup>1</sup>Milton Cobin furnished the description and photographs of the Mangos and the carissa.



*Fig. 1. No. 7, Byars Avocado*



is 14.7 percent in fruit picked in late November. This seedling is free from scab and withstands wind and cold well. The time of bloom and the flower opening behavior are still to be determined for this seedling. The lateness of the fruit maturity of this variety makes it interesting.

#### NO. 8. ETTA AVOCADO

Originated on the place of C. E. Good, east of Kendall, Florida, as a seedling of Lula possibly fertilized with Pollock pollen. At present the tree is 12 years old with good vigor and an upright habit of growth. Aside from severe damage by the 1945 storm the tree has been very productive.

*Description of fruit.* The fruit is an early season variety maturing from August 15 to September 15, large in size and light green in color, marked with lighter longitudinal stripes (Fig. 2). Its measurements are 4 by 6 inches approaching 2 pounds in weight, 18 percent of which is seed. Many of the fruits are pyriform with a heavy neck, others are obovate in shape giving two distinct forms to the fruit. Its skin is smooth and glossy of a heavy, leathery nature separating readily from the flesh. The rather thick flesh is yellow to the center and a dark green at the skin side having a buttery texture with a mild flavor. The oil content is low being *only 3.1 percent*. The seed is loose in the fruit with the coat adhering to the seed. The productivity of the tree may overcome the handicap of being a large fruit marked with a distinct striping.

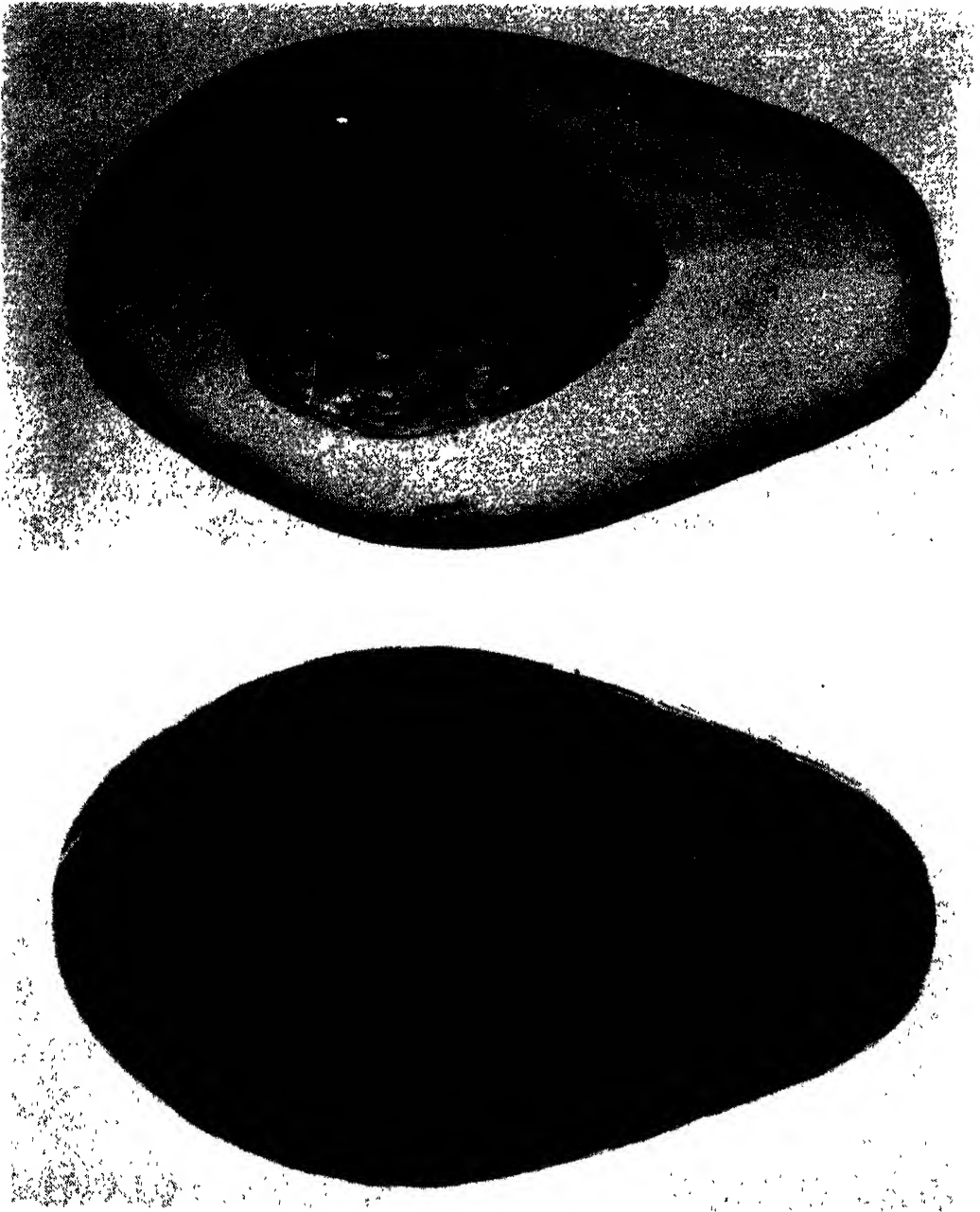
It is reported that this tree and fruit is hardy to frost and not susceptible to diseases. The time of bloom, flower opening behavior, and the behavior of

this variety as a clone are still to be determined.

#### NO. 9. GLENN MANGO

This mango is a Haden seedling planted on the property of Roscoe E. Glenn, 2931 S.W. 21 avenue, Miami, Florida. The seed was planted in 1940 and transplanted to its present location in Mr. Glenn's backyard in 1943, making the tree now 8 years old having a diameter of 6 inches at 1 foot from the ground with a limb spread and height of 20 feet. The seedling first bloomed in 1945 when four fruits were permitted to mature. No fruits were produced in 1946. In 1947 and 1948, 40 and 75 fruits matured, respectively.

*Description of fruit.* Form oval to somewhat oblong (Fig. 3); size medium to large; weight 373-505 gms.; average length 11.38 cm.; average width 8.19 cm.; average thickness 7.50 cm.; base rounded; the rather slender stem inserted obliquely in the shallow grooved cavity; apex bluntly pointed; beak none, the stalk is somewhat raised but inconspicuous, located about  $3\frac{1}{2}$  cm. from the apex on the ventral side; surface smooth; skin thin, tough, and easily separated from the flesh having slight bloom, ground color bright yellow, blushed orange red on the exposed side, with numerous small yellow and white dots; flesh deep yellow, firm and juicy; flavor rich, aromatic and spicy; aroma strong but pleasant suggesting pineapple; fibre scanty, short and of fine texture; quality, excellent; stone making up 7 to 8 percent of the total weight of the fruit, being oblong to long in shape; seed is monoembryonic filling about three-fourths of the husk; season June and July ripening about 7 to 10 days earlier than the Haden Mango.



*Fig. 2. No. 8, Etta Avocado*

## No. 10. LUCILE MANGO

This fruit is said to be a third generation seedling containing Saigon race, Haden and Brooks parentage. The tree is approximately 12 years old, vigorous grower, and has an upright spreading habit. The leaves are medium sized and are dark green. The 1948 crop was medium. The tree is the property of Mr. Roy Page and is planted approximately 30 yards southeast of his residence near Matheson Hammock Park near North Kendall Drive in Dade County.

*Description of fruit.* Form oblong to oblong-ovate, fairly plump (Fig. 4); size medium to large; weight 432-501 gms.; length 11.2 to 12.8 cm.; width 8.1 to 9.0 cm.; thickness 6.5 to 7.5 cm.; base flattened, somewhat oblique, the slender stem inserted squarely in the small shallow grooved cavity; apex rounded to bluntly pointed; beak none, the nak is slightly raised in a shallow cavity located about 3 cm. from the apex on the ventral side; surface smooth; skin thick, tough, easily separating from the flesh; bloom none; ground color yellow-orange, blushed crimson which is speckled around the shoulder, numerous yellow-russet dots present; flesh tender juicy deep yellow to orange; flavor, rich, spicy similar to the carrot flavor often found in fruits of Saigon race; aroma weak, pleasant; fibre scanty with concentration of coarse long fibre along ventral side of seed particularly abundant near shoulder; seed monoembryonic, stone thick and woody; quality good; season June and July.

## No. 11. HEINLEIN MANGO

The origin of this seedling is uncertain, but believed to be a seedling of the Mulgoba. The parent tree is estimated

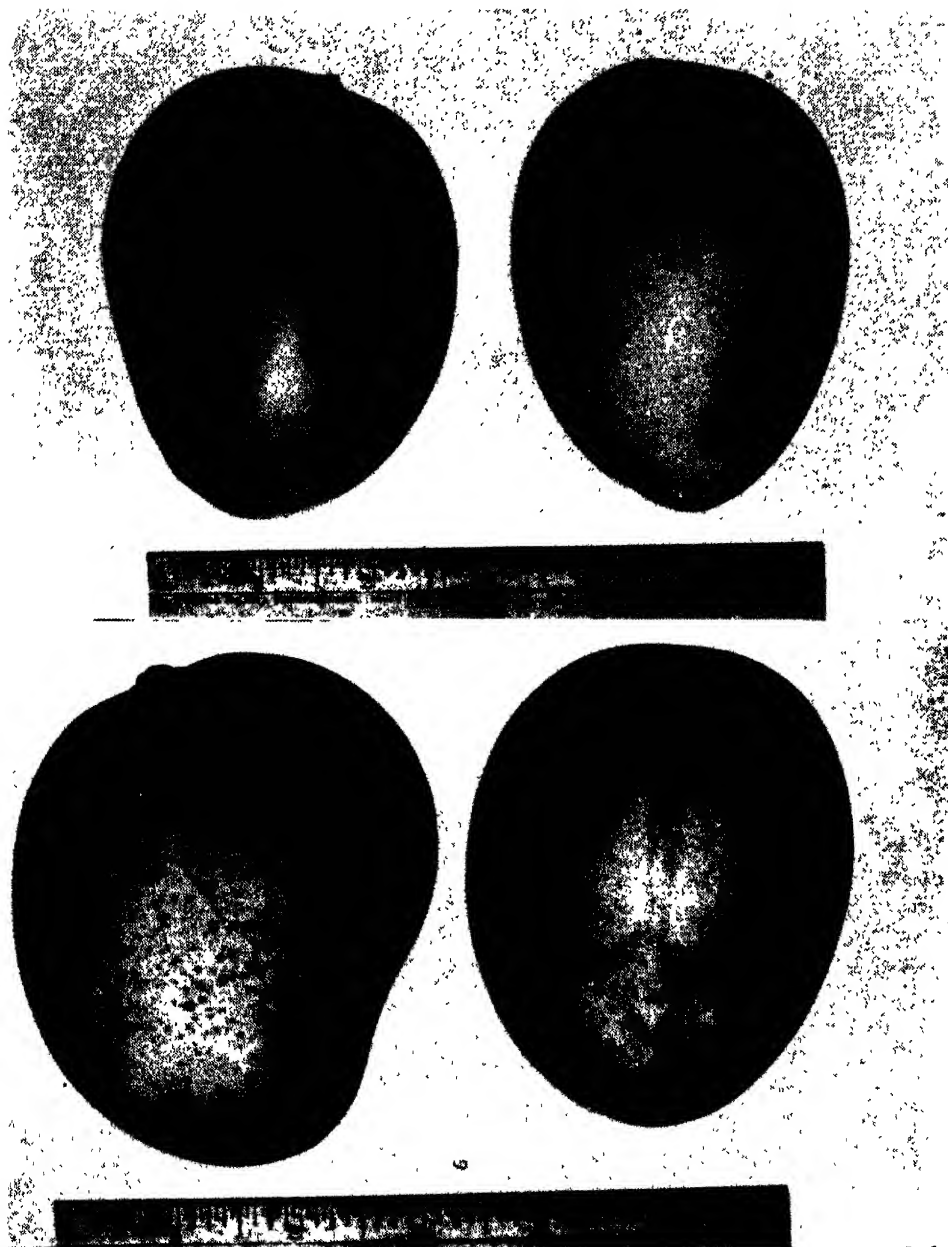
to be about 20 years old. This tree was almost blown over during the 1945 hurricane and was severely pruned and righted. During 1947 the tree produced 1½ bushels of fruit and in 1948 over 4 bushels of fruit were matured. The parent tree is the property of Mr. Herman Heinlein and is located on his property at Coconut Palm Drive just off Yetter Road in the Redland District of Dade County, Florida.

*Description of fruit.* Form oval, size medium (Fig. 5); weight 285-466 gms.; average length 10.4 cm.; average width 8.0 cm.; average thickness 7.30 cm. Base somewhat flattened, the stout stem is inserted squarely; cavity none; apex rounded; beak none to obscure, the nak is inconspicuous and is level or slightly raised located about 2 cm. from the apex on the ventral side; surface undulating, skin medium thickness, tough and rather adhesive to the flesh; bloom slight; ground color yellow-orange, blushed crimson-coral on the exposed side with numerous large yellow-white dots; flesh firm juicy pale yellow to lemon color; flavor mildly sweet; aroma none; fibre scanty, short and of fine texture; quality fair to good; stone making up approximately 7 to 8 percent of the total weight of the fruit, being oblong to long in shape; seed is monoembryonic filling about three-fourths of the husk; season June and July.

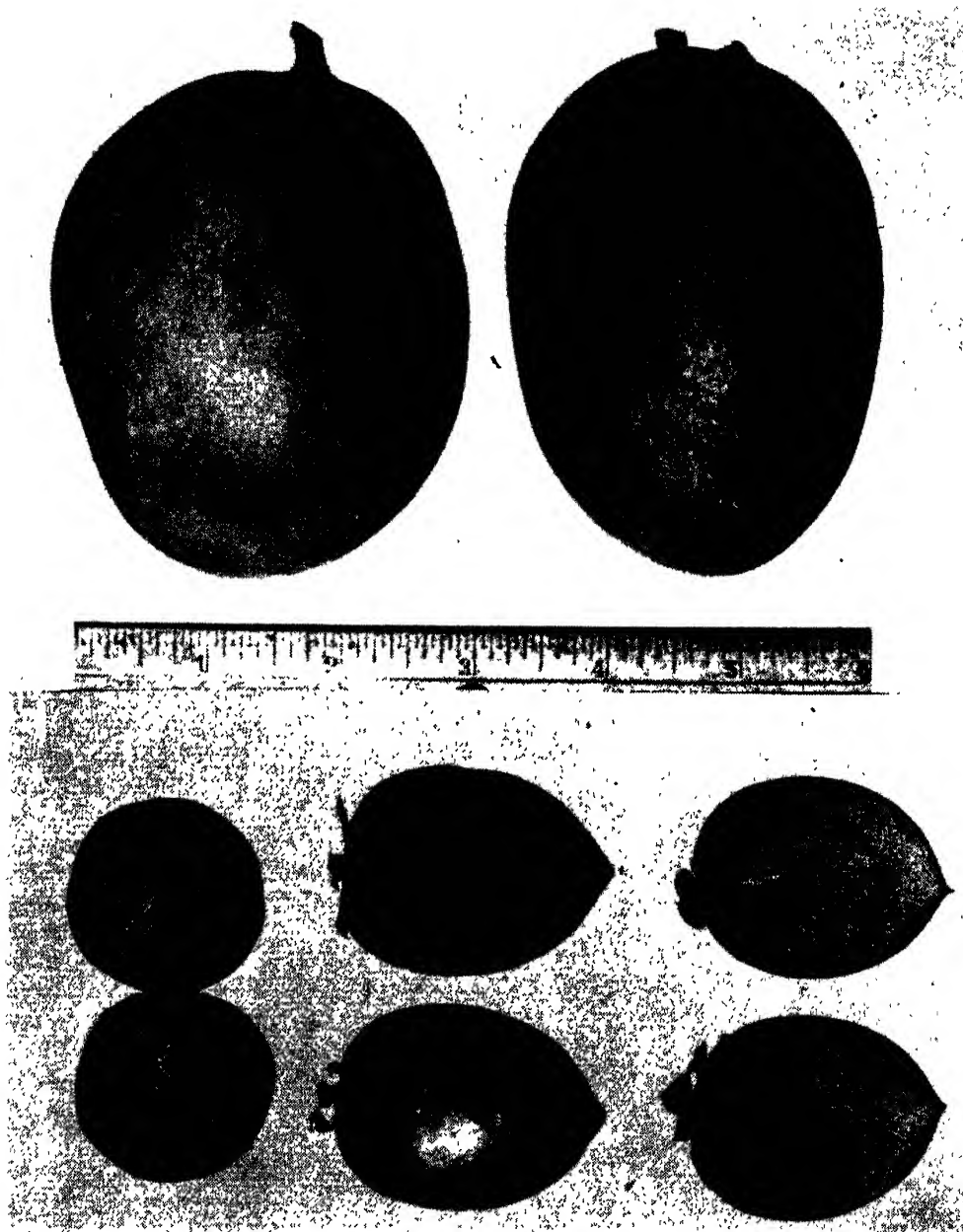
## No. 12. HORNE CARISSA

A seedling grown from seed obtained from A. S. Horne of California by David Sturrock of 1021 Camellia Road, West Palm Beach. This selection is being propagated.

*Description of fruit.* Shape broadly ovate (Fig. 6); base slightly indented to flat; apex variable, obtuse to somewhat



*Fig. 3. No. 9, Glenn Mango (Top). Fig. 4. No. 10, Lucile Mango (Bottom)*



*Fig. 5. No. 11, Heinlein Mango (Top). Fig. 6. No. 12, Horne Carissa (Bottom)*

rounded; weight 15¼ to 22 gms.; length 1¼ to 1½ inches; width 1¼ to 1 3/16 inches; color cranberry red beneath whitish bloom; dots inconspicuous; surface texture smooth; skin paper-thin; flesh somewhat grainy texture; flesh

separates readily from skin; flavor slightly acidulous to sweet; quality good; seed cavity approximately one-third diameter of fruit. Seeds 10-12 per fruit measuring ¼ in. long, ⅛ in. wide, 1/32-1/16 in. thick; tan to light brown color.

## THE FREEZING PRESERVATION OF SOME TROPICAL AND SUBTROPICAL FRUITS

MARGARET J. MUSTARD AND  
ARTHUR L. STAHL  
*University of Miami*  
Coral Gables

Although considerable information has been published during recent years pertaining to the freezing preservation of Northern fruits and vegetables, comparatively little information is available regarding the freezing of tropical and subtropical fruits. It is only natural that people living today in areas where these latter fruits are grown should seek information concerning the freezing properties of these fruits.

Freezing preservation provides a means whereby these delicious fruits can be enjoyed throughout the year even in areas far removed from the point of production. It is quite possible that many people will first make their acquaintance with these fruits as frozen products for it is difficult to ship some of the fresh fruits due to their highly perishable nature.

The following paper is in answer to numerous requests which have been made for information with reference to the results of investigations now in progress at the University of Miami in this

field. As this report is of a preliminary nature, further investigations may result in modifications of the procedures recommended below. It is hoped, however, that the following information may be of value to those wishing to freeze these fruits either as home or commercial products at the present time.

### MANGOS

A number of different frozen products can be made from the mango, the choice of which depends upon the stage of maturity of the fruit. Below are described a number of products which can be made throughout the mango season, beginning with the immature and ending with the soft ripe fruits.

Green "drops" can be made into a mango puree which differs considerably in flavor from other mango products. After the young fruits have been boiled in water until the skins begin to split open, they are removed from the water and peeled. The flesh is scraped from the seed and mixed in a food blender with approximately an equal volume of sugar, or sufficient sugar to produce a puree of the desired sweetness. The resulting puree forms a smooth, sometimes gelatinous, mixture. It can be frozen in various sized moisture-vapor-proof con-

tainers. Green mango puree makes a delicious filling for tarts and pies or can also be served in much the same manner as applesauce.

The green mangos can also be utilized as a frozen spiced compote. The flesh of the green fruit is cut into small cubes, cooked in boiling water until tender, and then transferred to a spiced syrup in which it is allowed to remain in the refrigerator overnight. The spiced syrup (1) consists of the following ingredients:

Sugar .....	14.0 lb.
Vinegar (cider vinegar of 4 percent acetic acid) .....	3.0 pt.
Water ...	7.0 pt.
Ginger root, broken . . .	$\frac{1}{2}$ oz.
Whole cloves .....	$\frac{1}{2}$ oz.
Stick cinnamon . . . .	$\frac{1}{2}$ oz.

The following day, the mango is packaged together with sufficient spiced syrup to cover the fruit and the product frozen. This product, served either hot or cold, makes a delightful meat and poultry accompaniment.

Firm ripe fruit can be prepared as a sliced or diced product. The fruit is peeled, sliced, or diced and placed in a moisture-vapor-proof container. The pack can be sealed without addition of any solution; a light sugar of from 15 to 30 percent can be added; or a limeade can be poured over the sliced product. The tartness of the limeade should be varied so as to enhance the flavor of the fruit. This product is used in much the same manner as the freshly sliced fruit.

Soft ripe and fibrous mangos can be made into purees. These products are prepared by pureeing the flesh of the fruits in a food blender, pressing the puree through several layers of cheesecloth to remove any fibres which may be present and packaging the resulting

puree. A quart of this frozen puree added to approximately a gallon of limeade makes a delightful tropical punch. The puree can also be served as a fruit spread.

#### AVOCADOS

Further investigations are underway in an attempt to find additional ways of preserving the avocado by freezing. The creamy consistency of the flesh of this fruit makes it very well suited for the production of frozen purees and spreads. A delightful puree can be prepared by mixing together in a food blender two-thirds by volume of avocado pulp, one-third by volume of a good grade of salad dressing and a small amount of salt. The mixture is blended to a smooth consistency and packaged in moisture-vapor-proof containers. As the surface layer of this puree tends to darken if a partially used jar is stored in the refrigerator, it is advisable to package avocado puree in 2- or 3-ounce jars so that a jar can be completely used soon after it is opened. Variations of this puree can be made by blending in some mustard along with the salad dressing and salt prior to freezing or by adding chopped onion or onion juice to the puree just before serving. Avocado puree spread on crackers or made into open-faced sandwiches make delicious appetizers.

Due apparently to the consistency of the flesh of the avocado, no satisfactory means has yet been found for freezing the sliced product.

#### LYCHEES

A simple, and at the same time, very satisfactory method of freezing lychees has been found. The unpeeled, freshly picked fruits are placed in moisture-vapor-proof containers, the containers

sealed and then placed in the freezer. These fruits can be stored in a frozen form at least 2 years without apparent change in flavor or color. After removal from storage, the fruits are peeled and eaten out of hand while still partially frozen. A recently published article (2) mentions the work which Lindner and Storey are doing with lychees in Hawaii. They recommend that the fruit be peeled, seeded, and packed in syrup for freezing. This type of pack was tried and although quite satisfactory was somewhat more difficult to prepare and was not quite as attractive as the frozen, unpeeled fruit. It is hoped that freezing preservation will provide an opportunity for more people to familiarize themselves with this delicious fruit.

#### BARBADOS-CHERRY

In the past, the barbados-cherry has been used chiefly in the production of jelly. Since the fruit has recently been found to be an excellent source of ascorbic acid (3), investigations were undertaken to determine what satisfactory frozen products could be made from this fruit thereby retaining a greater percentage of ascorbic acid than is possible with a cooked product such as jelly.

To date, the most satisfactory frozen product prepared from the barbados-cherry is a puree. The puree is prepared from freshly picked, ripe fruit. The whole fruits are washed, placed in a food blender, and ground to a smooth consistency. The resulting puree is pressed through several plies of cheesecloth to remove any seed fragments and is returned to the blender where it is mixed with approximately one-half its weight of granulated sugar and a small amount of citrus pectin. Sufficient pectin should be added to produce a

puree of the desired consistency. This product is then packaged in moisture-vapor-proof containers and frozen. A delicious tropical punch can be prepared by adding  $1\frac{1}{2}$  quarts of the frozen puree to a gallon of limeade. If the punch is to be served from a punch bowl, it is recommended that the frozen brick of puree be added just before serving as it will help chill the punch and will also add a touch of color and interest to the punch as the frozen product disintegrates. This puree can also be used as a topping for ice cream or as flavoring in the ice cream itself.

#### GUAVAS

The guava, also an excellent source of ascorbic acid, can be frozen either as a sliced product or as a puree.

In preparing frozen sliced guavas, the fruits are washed, peeled, the seeds removed, and the flesh cut into longitudinal sections. The slices are placed in moisture-vapor-proof containers and covered with a light sugar syrup prior to freezing. Frozen guava slices are used in much the same manner as the freshly sliced fruit itself.

A puree can be prepared either from the peeled or unpeeled fruit. If the skin of the fruit is free from blemishes, it is recommended that the skin be included as it contains the highest concentration of ascorbic acid (4). The fruit is ground to a smooth consistency in a food blender and pressed through several layers of cheesecloth to separate seed fragments and stone cells from the puree itself. A small amount of sugar may be added to sweeten the product if desired. The appearance of purees prepared from fruits having delicately colored flesh can be improved by the addition of a small amount of red artificial food coloring or



juice from some highly colored fruit such as the antidesma. The puree is delicious when used as a spread on hot toast and may also become a popular baby food due to its high nutritive content.

#### BANANAS

Miami is one of the ports of entry for bananas arriving from Central America and West Indies. Many of these fruits at the time of arrival here, although in excellent condition, are too ripe to stand further shipment to the Northern markets. It was therefore decided to investigate the possibilities of utilizing these fruits in the production of a frozen banana puree, which in turn might be used in the manufacture of baby foods.

Firmly ripe bananas were selected from several shipments for the investigation. It was necessary to take special precautions to retard the darkening or oxidation of these fruit during the preparation for freezing and subsequent storage. Steam-blanching the unpeeled fruits for 8 minutes almost completely prevented subsequent darkening of the flesh. If the fruits were peeled before blanching, not only was a considerable quantity of "milk" lost during the blanching but some darkening occurred between the time the fruit was peeled and when it was blanched. After the fruit was blanched and peeled, it was blended to a smooth consistency in a food blender or puree machine and packaged. Ten-pound cans were used for packaging this puree made in cooperation with a local freezing concern. Before closing the cans, ascorbic acid was sprinkled over the surface as a further precaution against oxidation. The frozen puree was shipped to a Northern baby food manufacturer to be made into a finished baby food.

#### PINEAPPLE

During the past few years, a considerable quantity of pineapple has been frozen on a commercial basis. As local interest has recently been shown in the varietal suitability of the various pineapples grown in this area for freezing, an investigation was undertaken to determine which of the locally grown pineapple are best suited for freezing and which types of packs are best for each variety.

The fruits used in this investigation included the Abachi, Smooth Cayenne, Red Spanish, Eleuthera, Natal Queen or Queen, and a group believed to be of the Hilo variety. The fruits were peeled, cored, and the flesh cut into small pieces or "tidbits." Four types of packs were made from each variety: first, the plain or dry pack in which no sugar or syrup was added; second, the dry sugar pack in which one part by weight of sugar was mixed with four parts by weight of fruit; third, the syrup pack in which syrups of various percentages of sugar were poured over the fruit; and fourth, the blanched, syrup pack in which the pineapple was steam-blanching for 4 minutes and cooled prior to the addition of the syrup. All of these samples were frozen and stored in moisture-vapor-proof containers. After approximately 6 months storage at 0°, the samples were thawed and compared as to flavor, color, and texture. The results can be summarized briefly as follows:

(1) *Plain Pack or Dry Pack.* This type of pack was particularly well suited for fruits of the Natal variety, an exceptionally sweet fruit.

(2) *Dry Sugar Pack.* The dry sugar pack was found to be a convenient type

of pack for home freezing. The ratio of sugar to fruit can be decreased somewhat for the sweeter varieties.

(3) *Syrup Pack*. It was found that samples prepared with 15 to 30 percent syrup were superior in flavor to those prepared with heavier sugar syrups.

(4) *Blanched, Sugar Pack*. The blanched samples had a cooked flavor similar to the canned product and were not rated as highly by the judges as the unblanched samples.

The flavor of products prepared from the Smooth Cayenne, Natal, Hilo, and Red Spanish were judged superior to those prepared from the Golden Abachi and the Eleuthera varieties. The naturally brighter color of the Smooth Cayenne and the Natal were retained during freezing and were judged superior in this respect to the other varieties. Little difference was noted in the texture of the samples prepared from the various varieties of fruit.

Further investigations are planned in an attempt to determine if some factor or factors other than inherent varietal differences may have been responsible for the poorer flavor of the Golden Abachi and the Eleuthera products.

The above discussion has been confined to but a few of the tropical and subtropical fruits under investigation. Throughout each year as the various fruits mature, their freezing properties

are being determined. Among the other fruits which have so far been frozen are the soursop, papaya, monstera, antidesma, carambola, and a number of citrus fruits.

#### SUMMARY

The foregoing paper summarized briefly some of the investigations completed to date on the freezing of such tropical and subtropical fruits as the mango, avocado, lychee, barbados-cherry, guava, banana, and pineapple. It is evident from the above that many of these fruits are well adapted to freezing preservation.

#### ACKNOWLEDGMENT

The authors wish to acknowledge their indebtedness to the local growers and packers who supplied many of the fruits used in this investigation.

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## PLANT INTRODUCTION AS A HOBBY IN PALM BEACH COUNTY

LAWRENCE M. SIMONSON, M.D.

Lantana

As a contribution to the horticulture of

the coastal section of Palm Beach County, I have been asked to write a paper on my hobby of raising new plants, and especially trees and usually from

seed. Since I have lived here only since 1945, many of my remarks and conclusions may be rather premature, but I'll do my best.

Unusual trees are my especial hobby. From my earliest recollections, growing things have always interested me, but I can look at other people's hibiscus and coconut palms and enjoy theirs—I don't have to own them. However, for a good many years, I have been collecting plants and have gathered quite an assortment of unusual things, many from the Washington Bureau of Foreign Plant Introduction for the past 20 years. Rare plants are not necessarily the most beautiful, but to a plant lover, rarity does create added interest.

I have lived in Florida for over 30 years, but most of that time in Polk County, where my location was too cold for many of the interesting tropical things I wanted to grow. I decided to move here, to Lantana, 6 months before Pearl Harbor, but the war prevented until 1944-1945, and many plants had to be kept in containers too long. As many as possible of my plant collection were brought over and most of them are doing very well, considering all conditions. There are no tombstones to mark the ones that have died—there would not be many.

I chose my location here at Lantana because the temperature records seemed to show as much freedom from frost as any location in Florida that was not subject to ocean salt spray, and on my hill I have air drainage to afford an additional protection on still, frosty nights. And from the native growth on my hill-top of slash pine, scrub oak, and dwarf palmetto palm (*Sabal*) over the yellow subsoil, it seemed that the soil was fairly good for southeast coastal Florida. The

pH was around 5.5. Plants which do not thrive in the alkaline soils of Dade County might succeed here in Palm Beach County. So far, I have been well satisfied with my choice; of course, I know that frost is always freakish and anything can happen. I expect to stand a stove by my *Barringtonia* occasionally.

For quick landscape effect, one can purchase plenty of good and desirable plants. However, for my interest, I would rather raise them from seed, because how else can new species be gotten into the country, and, unless the plant is well known, commercial nurseries cannot afford to bother with them. This takes time and patience after you have gotten the seed but it is much the most interesting way—how it sprouts—how its root system develops—and how the leaves change from juvenile to mature form, and of course, later the flowers and fruit. Each species has its own habit of development. I have been fortunate in being able to obtain seeds from a number of different sources, many from Mr. E. A. Menninger of Stuart, who has a similar hobby as mine. Also a number of other sources have kept me supplied with about all I have been able to take care of with my amateur facilities and only my two hands for dependable help.

Many tropical seeds lose their vitality very quickly, and hence there are many things that we do not yet have in this country. I hope that with the new air parcel post delivery these difficulties of getting viable seeds will be solved eventually.

Reasonably fresh seeds brought in from Central and South America and from South Africa have germinated and grown pretty well. Also those from Australia have mostly started very well, though many of them are impossible

here because of their damping-off habits. A correspondent in New South Wales says that even there they usually dig the young wild plants in their native locations and pot them up to get them established. This applies principally to the native *Proteads*, of which they have such a variety and some of which are very beautiful. A few of that group are thriving here—*Macadamia*, *Grevillea*, and *Stenocarpus*, but I have tried four or five others: *Banksias*, *Teloepas*, *Embothrium*, *Lambertia*, and *Leucodendron*, and while they all sprouted well enough, they all damped-off after making 3 or 4 leaves at most. I am inclined to think that a *Mycorrhiza* is necessary for them.

I have had a good number of varieties of seed from India and southeast Asia, mostly from a commercial seedsman in Darjeeling, but I have no way of knowing how these seeds were handled before I received them. These are the ones which I have found most uncertain as to viability—many times none germinate, but occasionally one or two seeds do; seldom very many, unless they are very small seeds. Small seeds retain vitality longer than large ones. But these Indian seeds are the ones which I feel possess most interest for us here in Florida, because they are apt to be plants which California does not already have. If California has plants, we can get them from there, but things like the mango which require a warmer climate than California possesses might do well here in Florida.

As I said before, I like to watch how the different seeds vary in their development; how the taproot starts, because that is going to be the foundation of the mature tree. So many of the plants I have received in the past 20 years

from nurseries and from the plant introduction gardens have been kept in small containers so long that they can never make a good tree—the taproot is so coiled up and deformed. It is the habit of some species to make the root system from that original radical.

Other plants are not so set in their ways, or do not develop a taproot at all. A seedling lychee makes a very strong taproot at once with very little top for a year or more. No doubt air-layered plants form a taproot eventually. I have been especially interested in this behavior, because for my deep dry sand it would seem to be especially important if the tree is to reach moisture. And for this reason, I try to watch the tendency of the roots by turning them out of their pots once in a while, and as soon as I see evidences of one root coiling 'round and 'round the bottom of the pot, or coming through badly, I try to plant it out in its final location at once with the root going as straight down as possible, sometimes even tying the coiled root to a stick to insure its position. The stick and string will of course rot eventually. Of course, this makes for slower development because it is much harder to care for the young plants scattered over a wide area than in the nursery, but eventually one will have a better tree. Many no doubt would grow faster on lower, moister land, but I use what I have, and results have not been too unsatisfactory, and I think I have quite a number of things that would not grow at all on wetter soil. You can add water, but you cannot always take it away fast enough.

Many of the seeds I have been trying are new in cultivation, having been collected in the wild, and even the collector who may or may not be a botanist may not know just what he has because it

may be a new species, or he may not have been able to see the flowers when the seed was ripe. Or the native who brings him the seed has only some local name, which usually gives no more information than "tree with yellow flowers," for instance. So it is very much of a gamble, but to some that adds interest. I recently had three lots of seed from Nyassa Land, East Africa, labeled three species of *Bauhinia*. All three are developing into *Albizzias*; I guess they are going to be. At least, there is always something new to watch for.

Some of the more or less unusual young trees, other than those from the U. S. Bureau of Foreign Plant Introduction, which are growing with fair promise on my hill are:

*Acacias*—7 or 8 of the Australian species. Hurricanes are bad for them. They do not flower well in Florida, but they are well worth growing for their beautiful foliage.

*Albizzia Coriaria*, *Stipulata* and *Zygia*.

*Bauhinia*—5 or 6 species.

*Brexia Madagascariensis*—Stands hurricanes well.

*Brownea Grandiceps* and *Macrophyllia*.

*Byrsonima Cotinifolia*.

*Calliandra Anomala* and *Haematocephala*.

*Calophyllum Antillanum* and *Calaba*.

*Calycophyllum Candidissimum*.

*Chrysophyllum Cainito*.

*Clitoria Amazonica*.

*Couroupita Guianensis*.

*Crescentia Cujete*.

*Dombeya*, *Burgesac*, *Elegans* and *Dregeana*.

*Eucalyptus Ficifolia*, *Polyanthema* and *Pruinosa*.

*Eugenia Hookeriana* and *Malaccensis*.

*Filicium Deciapiens*—This is one of my special favorites. MacMillan ranks it as one of the most ornamental trees of Ceylon.

*Ferdinandia Magnifica*.

*Lonchocarpus*—Three or four species.

*Lagerstroemia Thonalli* and *Turbinata*—These are both good. *Houarssi* and *Tomentosa* are small but promising.

*Medinella Magnifica*—Grows well enough, but should have more shelter from winds.

*Napoleona Imperialis*—Was good until 100 mile gale winds hit it. It will come back.

*Norantea Guianensis*—A very beautiful vine, said to be.

*Nuxia Floribunda*.

*Putranjiva Roxburghi*—Seems especially promising as a symmetrical tree.

*Tibouchina Granulosa*.

*Triplaris Surinamensis*.

*Vitex Altissima Alata*.

Before the 1947 hurricanes I had good specimens of *Butea Frondosa* and *Schizolobium Excelsum*, but that wind was too much. There are a number of others, but as yet too young to list here.

# NOTES ON THE CHEN-TZE LYCHEE OF HENGHWA, FUKIEN, CHINA

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Lychee is indigenous to southeastern China. Its culture has already been established here for a long time (Ts'ai-Hsiang, 1059; Groff, 1921; Li, 1946). Today it still is one of the most important commercial fruits of the country. Fukien and Kwangtung are the two most important lychee producing Provinces of China, and the two together yield the bulk of the lychee of commerce. Before World War II in 1937, Fukien alone had 15,652 market-acres<sup>1</sup> in lychee and produced 318,554 market piculs<sup>2</sup> (about 35,114,557 lbs.) of the fruit in that same year (Statistical Division, Fukien Government, 1946.)

There are many important centers of lychee production in Kwangtung but the most important areas in Fukien are Henghwa, Choanchow, and Changchow, among which Henghwa is by far the most important.

In the past, several attempts have been made to introduce the lychee to the United States of America. Of these, the ones made in 1903 and 1906 by the late Rev. W. N. Brewster, then a missionary in Henghwa, have proven most successful. As a result, the lychee in Florida is now called the Brewster lychee. Being a lychee specialist, Professor G. W. Groff wanted to find out the real varietal name

of this so-called "Brewster" lychee. It was at the suggestion of Professor Groff that the authors visited Henghwa in July 1948, and the following notes gathered are recorded.

In the absence of final proofs that the Chen-tze of Henghwa is the Brewster lychee of Florida, it is thought best to include a brief description of the fruit, a photograph and some notes on its composition to form a basis for future comparison with the Florida material. Ascorbic acid was determined by Ballentine's method (1941). The determinations of carbohydrates and total acidity followed that of the official methods of analysis of the A.O.A.C. (W. W. Skinner, personal conversation, 1940).

## SOME PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE CHEN-TZE LYCHEE

Specimens for study were collected from the Kwanghwa Farm in Henghwa. Thirty fruits were used in the chemical and physical measurements and 10 fruits were preserved and kept in the museum collection of the Pomological Laboratory in Fukien Christian University.

A brief description of the fruit is given here. Trees are usually planted along the canals or along the edge of rice fields, where they attain 25 to 45 feet in height or taller, depending on their ages. Above the ground, the trees form a dense head with dark green foliage. The individual leaflets are lanceolate in shape and acuminate at the tip, short petioled, and of dark green hue. Fruits round to cordate in form with raised shoulders,

<sup>1</sup>A market acre equals 7175.91 sq. ft.

<sup>2</sup>A market picul equals 110.23 lbs.



Figure 1 (Li and Chou paper) Chen-tze lychee from Henghwa, Fukien, about one-fourth natural size, showing one fruit on the left with the dark peel removed. Two seeds above, the large seed very rare.

one of which is more prominently raised up than the other. The fruits measured 3.62 to 4.25 cm longitudinally, and 3.22 to 3.65 cm in cross section. The surface of the fruit is very rough with sharp points (Fig. 1). The color of the fruit is purple red and the inner coating of the "skin" is characteristically pale red in color. The pulp is white, firm, and juicy with almost no rag, very sweet in taste. A very high percentage of the fruits is small-seeded. This variety ripens its crop about the middle of July and is considered a high quality fruit.

The laboratory measurements of some physical and chemical properties are tabulated in Table 1. The figure for ascorbic acid content is slightly low in the above since the fruits collected on July 18 did not get analyzed until July 21. During transit there are chances for this acid to deteriorate. The physical and chemical data compared favourably with those given by Stahl (1935), who worked on lychee material collected from Homestead, Florida.

TABLE I  
SOME PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE  
CHEN-TZE LYCHEE FROM HENGHWA, FUKIEN  
(Based on a study of 30 fruits)

PHYSICAL		CHEMICAL	
Total wt. of 30		gms reducing sugar in	
fruits, gms :	513.00	100 gms pulp:	6.67
Percarp % :	16.08	gms inverted sugar in	
		100 gms pulp:	7.26
Pulp % :	75.56	mg's ascorbic acid in	
		100 gms pulp:	22.41
Seed % :	8.36	gms total sugar in	
		100 gms pulp:	13.93
		total acidity in	
		0.1N NaOH/10 cc juice:	5.24

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## ADDITIONAL NOTES UPON THE HISTORY OF THE "BREWSTER" LYCHEE

THE LIFE OF TS'AI HSIANG AND HIS RECORDS OF THE CHEN FAMILY  
PURPLE LYCHEE OF HENGHWA, FUKIEN, AND THE RELATIONSHIP  
OF THIS VARIETY TO "BREWSTER" IN THE LIGHT OF THE  
LI AND CHOU PAPER

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Laurel

A new fruit industry for Florida, based upon the so-called "Brewster" lychee, now is being rapidly established by the large scale propagation of a plant introduction into the United States, believed to be that of inventory number 21204 of the Seed and Plant Introduction of the United States Department of Agriculture, from Henghwa district, Fukien Province, China. The plants under this number, secured by the Reverend William N. Brewster, were brought into this country largely upon Mr. Brewster's own initiative. The Reverend Brewster, now deceased, and several members of his family long have been faithful missionaries of the Methodist church in the interior district of Henghwa, Fukien, accessible through the port of Foochow.

Henghwa has been renowned throughout China for nearly 9 centuries as the

result of a famous lychee monograph written by Ts'ai Hsiang, a Fukien Chinese scholar, calligrapher, engineer, and government official. Fine penmen in China emulate the artistic handwriting of this great man.

In 1918 a wealthy Chinese friend of mine invited me and Mrs. Groff, and Dr. and Mrs. Walter T. Swingle to dinner at his home in Canton. After dinner he laid a beautifully bound portfolio on the table where I was seated. This was a complete copy of the *Li Chih P'u*, the famous monograph of the lychee grown in Henghwa district, Fukien, consisting of the rubbings made from the famous stone monument erected in 1059 A.D. by order of the Chinese Emperor to honor Ts'ai Hsiang for his remarkable monograph. By order of the Emperor, the text of Ts'ai Hsiang's monograph was cut, page by page, into the stone of the monument.

A few weeks later Dr. Swingle secured in Peiping another copy of this rubbing,



and began a diligent search for all printed or manuscript copies of this work. He succeeded in obtaining many copies of the *Li Chih P'u*, but Michael J. Haggerty, an efficient translator working at the great Chinese collection of the Library of Congress, found that most copies of this work were more or less defective, sometimes incomplete, since the individual slabs of stone covered with inscriptions on the monument are not numbered.

In 1926 Mr. Swingle was a United States Government delegate to the Third Pan Pacific Science Congress in Tokyo, and through the good offices of Dr. M. Shirai, a famous Japanese botanist, he secured a photographic copy of the first reprint of *Li Chih P'u*, printed in a very old authentic Sung edition (from a collection of reprints, the *Po ch'uan hsueh hai*, dated 1228 A.D.) in the great Imperial Household Library of Japan. Mr. Haggerty found this copy to be the only complete and correct copy in the Library of Congress.

The monograph *Li Chih P'u* is now receiving world recognition, largely because of the wider world dissemination of the lychee in culture, but also because this work has proven to be the *earliest known horticultural monograph of the varieties of a fruit tree*. It was the model that inspired Han Yen-Chih in 1179 A.D. to write the first special treatise on the orange. English translations of both of these monographs have been made by Michael J. Haggerty, and are available through the Library of the Department of Agriculture in Washington. I include a brief resume of Ts'ai Hsiang's work, based on Haggerty's carefully revised translation, from my book, "The Lychee and Lungan," p. 20:

"Ts'ai Hsiang's treatise on the lychee

is divided into 7 distinct chapters. In the first of these chapters he treats of the extent of territory over which the lychee is grown and proclaims his zeal to place this fruit in the position it deserves among the fruits of the world. He had artists draw pictures of the best varieties he had seen and these he classified. In the second chapter he deals with the lychee in his native province, Fukien, and he says that though there are a thousand varieties and ten thousand trees, no other one can compare with the 'Chen family purple lychee.' He says of it, 'When the Chen family are about to harvest their crop of lychee, they close all their gates or doors and people desiring to purchase the fruit must hand in their money through an aperture in the wall, receiving in return its equivalent in lychee fruit. For that which the purchaser was able to obtain he was thankful and considered himself lucky, never daring to argue whether the price was too much or too little.' He then deals with the production and export of the lychee and in the fourth chapter he considers its medicinal properties and speaks of the age of the tree and the excellent character of the wood. He does not fail to discuss the important fact of inability of the lychee to withstand cold and to speak of its chief enemies. In the sixth chapter he deals with a few of the many interesting methods of preserving the fruit which the Chinese used in those days and he tells of the custom of sending the best fruit as tribute to the Emperor. In the last chapter he gives a comprehensive list of the varieties produced and discusses them in some detail."

Some day a highly appointed western horticultural commission should travel to Henghwa to more widely recognize

and honor Ts'ai Hsiang. Numerous efforts were made by me during my service in China to proceed into this north range lychee district of Henghwa in order to learn more regarding the life of Ts'ai Hsiang, to see the beautiful stone bridge which he designed and had built at his birthplace, and particularly to study the kinds of lychee still growing within that area, and the cultural methods followed. Pressure of other duties, even as late as 1946 while in United Nations Relief and Rehabilitation service, always made impossible this proposed trip. Upon my request fortunately in July 1948, Dr. Lai-yung Li, whom many of you will remember pleasantly (when, as a PhD graduate of the Pennsylvania State College he visited Florida a few years ago), and Prof. Chou, his colleague at the Christian University of Foochow, Fukien, have studied somewhat more intimately the lychee of Henghwa, particularly as related to the "Brewster" of Florida. Their paper, now and in years to come, will be read as an interesting portion of the history of the lychee in the Americas.

The story of the introduction of the Chen-tze or "Brewster" lychee into the United States has never been told before, and even now is not totally clarified by these papers. While preparing my work "The Lychee and Lungan," published in 1921, I investigated as thoroughly as possible at the time the Brewster records in Washington. Apparently Mr. Brewster, as the result of his long residence in one of the few lychee producing areas of China, was so convinced of this fine fruit's worth that he wished to see it growing within the borders of his own country. As concluded by Li and Chou, may we all be stimulated in

the interesting history of Sino-American plant introductions by this report of the Chen-tze lychee.

I recall that I was told in Washington that the first shipment of the Brewster lychee plants in 1903, upon arrival on the Pacific Coast, were confiscated by quarantine authorities, but upon instruction from Washington they were turned over to Dr. David Fairchild's division of Seed and Plant Introduction. Li and Chou refer to two shipments of lychee from Henghwa to the United States by the Reverend Brewster, under the dates of 1903 and 1906. Plant inventories of the government report these introductions as S.P.I. No. 10670-10673 for the first shipment, and S.P.I. No. 21204 for the second shipment, dated October 1906.

It is apparent that the interest of Mr. Brewster in lychee introduction into the United States definitely was between the years 1903 and 1906. Why his interest lagged after the plants were taken over by the government is not yet revealed. Between July 1, 1907 and January 1908 Mr. Brewster sent from Henghwa to Dr. Fairchild's office interesting data regarding the culture of the lychee and the lungan. The photographs he submitted at that time were the first ever received by the government office showing the trees in bearing. Some of this data on the Chen-tze or "Brewster" lychee is recorded under S.P.I. Nos. 10670-10673 in the Bulletin of the Bureau of Plant Industry No. 97 (Inventory No. 11) 1907, pp. 35-36; and S.P.I. No. 21204 in the Bulletin of the Bureau of Plant Industry No. 132 (Inventory No. 13) pp. 140-141, 1908.

Regarding the subsequent distribution of the Chen-tze or "Brewster" lychee, S.P.I. No. 21204 by the government, my

notes show that from 9-29-07 to 2-7-18 plants were sent out from Washington as listed in Table I.

TABLE I

Area	Plants Sent	Cooperators To Whom Sent
Florida .....	46	11
California .....	12	6
Hawaii .....	3	1
Panama .....	4	2
Cuba .....	7	5
Isle of Pines .....	5	3
Trinidad .....	1	1
Porto Rico .....	6	3
Costa Rico .....	1	1
Brazil .....	4	2

Under Florida the 11 cooperators to whom plants were sent are the following:

John B. Beach, West Palm Beach, 1 plant.

Edw. Gottfried, Miami, 1 plant.

Plant Introduction Gardens, Miami, 7 plants.

George B. Cellon, Miami, 22 plants.

Wm. J. Krome, Homestead, 2 plants.

L. R. Nixon, Homestead, 2 plants.

S. B. Bliss, Buena Vista, 3 plants.

Dr. W. C. Richardson, Tampa, 3 plants.

W. S. Taylor, Tampa, 1 plant.

Chas. T. Simpson, Little River, Miami, 1 plant.

Reasoner Bros., Oneco, 3 plants.

Soil conditions in the Miami-Homestead area are not as ideal as within Ridge and West Coast areas of Florida for the cultivation of the lychee, but if maintained in an acid soil condition when young by the application of muck from the Everglades or acid soil from some other source, when more mature and beginning to bear the trees are able to tolerate alkaline conditions to some extent.

Reasoner Brothers, now the Royal Palm Nurseries, at Oneco, Florida; Mr. C. R. Tyson of DeSoto City, and Colonel Wm. R. Grove of Laurel, have been the chief contributors in further propagation of the Chen-tze or "Brewster" variety. We know further that numerous lychee trees have been fruited in California, where they have been planted on acid soil, and there are also areas of acid-clay soils in warm coastal regions in California which would support lychees well.

The name "Chen" is a well-known Chinese family name and this lychee long has been known as the "Chen family purple." Mr. Wen-hsun Chen, a Fukien student from Henghwa now at Gainesville, informs us that two trees, believed to be from the original planting, still survive. He says that upon the monument which stands near them it is stated that they were planted during the Sung Dynasty, about 853 A. D. He reports that one of these trees is 5.89 feet in diameter and 75 feet high.

Not only did Tai Hsiang reveal the virtues and cultural requirements of this fruit in his treatise of 1059, A. D., but from 1100-1126 A. D. a Sung dynasty emperor, Hui Tsung, is credited with having produced a famous painting of this fruit. That which is now believed to be this painting or a good copy of it was found by Dr. Walter T. Swingle in the Metropolitan Museum of Art in New York City, under the title in Chinese: "Chen Purple Lychee Embroidered Fragrant Bag."

A photographic reproduction of this painting appears as an attractive frontispiece of my book, "The Lychee and the Lungan," 1921, published by Orange Judd Co., N. Y. It also will be seen as Plate 12 in Dr. Walter T. Swingle's chapter on "Our Agricultural Debt to Asia"

in Arthur E. Christy's "The Asian Legacy and American Life," published in 1945 by the John Day Co., N. Y.

It is reasonable to believe, in line with that recorded by Li and Chou, that Mr. Brewster in preparing plants for shipment to this country would choose this variety. Strangely he gives no varietal names in his information presented to the United States Department of Agriculture. Moreover the physical and chemical data covering the Chen family purple as worked upon by Li and Chou, compares strikingly with that which we know regarding the "Brewster."

Li and Chou say that at least nine-tenths of the crop in Henghwa is composed of the Chen-tze lychee, which was undoubtedly the variety sent to America by Brewster. It is further significant to the development of the Chen-tze or "Brewster" lychee in Florida that Ts'ai Hsiang in his writings recorded as many as 12 forms of this variety or class known in Henghwa as the Chen family purple.

Quoting Ts'ai Hsiang: "The Chen-tze variety of lychee originated when the first members of the Chen family cleared the land and established their home. The

low-lying sections of this land were filled in and leveled off, after which the lychee trees were planted. Some say that the extraordinary fertility of this land is responsible for the good quality of this variety. At present when other people obtain this seed and plant it in a fertile place, they do not obtain such a good fruit." Thereafter follow 11 other varietal names related to the Chen-tze, being color names, with brief descriptions of the merits or demerits of the respective types.

The lychee is extremely variable in its fruit characters. Here in Florida we can expect new strains out of "Chen-tze" or "Brewster." And the possibilities for lychee varieties by further explorations in China and cooperation with the Chinese almost is endless. To extend the southern range of its culture in the Americas lychee studies should extend into southern Kwangtung, Hainan, Indo-China, Siam, Burma, and India. Fortunately we now have in the Chen-tze lychee, largely through the interest and efforts of the late Reverend Brewster of Henghwa, one of the very best lychee varieties for a northern, subtropical range area, such as Florida.

## THE KARANDA AS A COMMERCIAL FRUIT

DAVID STURROCK  
West Palm Beach

It is always interesting to watch the development of a new fruit being brought into commercial use. Many of the tropical fruits, especially the bush fruits, are still being propagated from seed. This is due to a lack of outstanding forms among these seedling plants as

well as to a lack of commercial use for the fruits.

This paper is given to draw attention to one of these miscellaneous tropical fruits that now appears to have commercial value. I refer to the *Carissa carandas*, Linn. commonly known in its native country, India, as the Karanda.

Early mention is made of the Karanda in several European horticultural papers

as an ornamental hothouse plant. Nicholson's "The Illustrated Dictionary of Gardening" published in London in 1884 describes the plant as—"Fl. milky-white, Jasmine-like; corymbs terminal and axillary, few flowered. July Lvs. ovate, mucronate or elliptic, obtuse, glabrous; spines often two-forked. Sub-arboraceus. Ht. 15 ft. to 20 ft. India, 1790. (L.B.C. 663 (Loddiges C) Botanical Cabinet, London. 1812-33. 20 vls." In Bailey's "Standard Cyclopedia of Horticulture" the same general description is given. Mention, however, is made of the fact that the corolla is twisted to the left in the bud. This is a distinguishing feature as the corolla twists to the right in the true *Carissa* sp. Bailey also mentions the fruit as being the size of a cherry, reddish in color and pleasantly flavored.

In "Plant Foods of the Philippines" Wester describes two species: *C. carandas*, the Karanda, "with roundish oblong black fruits of about the size of the ciruela but with dark red acid flesh;" the other smaller-fruited one "*Carissa carandas* var. *dulcis*, the Perunkilla" is described as "egg-shaped or roundish fruits about the size of a small cherry, containing a subacid juicy pulp of pleasant flavor." Illustration is also given of the two forms which are readily recognized among our own plants as seedling variations rather than distinct species.

In our own experience with this fruit in south Florida there has been evident a great deal of variation; one batch of seedlings, of seed from a single plant, will produce a great variety of types in foliage, productivity, size, and quality of fruit. We had found it advisable to bring the plants to fruiting before offering them for sale, due to a large percentage of poor quality fruits of undesirable

flavor among the seedlings. In general, the seedlings fall into two main types, the larger-sized acid fruit with 3-6 fruits in a cluster, and the smaller subacid type with 6-10 fruits in the cluster. The small subacid fruits are pleasant to eat out of hand, although most of them contain a latex that coats the lips.

Until recently we have given no more than casual attention to the Karanda in our nursery work. We have used the fruit in our home for several years for jelly and as a fruit juice for punches, and for flavoring ice cream and sherbets. It has been very difficult to propagate this plant asexually; tip cuttings do not strike roots readily nor were our efforts at ground or air-layering sufficiently successful for nursery work, especially with a casual fruit for home use not greatly in demand.

During the past year two things have happened to give a different aspect to the situation. About a year ago we gave some of the juice to a soda fountain operator who became interested in it and has successfully worked it up into a very good soda fountain syrup. There is now a demand for the Karanda flavor at this soda fountain but the supply is not yet up to the demand. The other thing that has happened to influence the value of this fruit is the use of plastic wrappings for air-layering. The Karanda is slow in forming roots but this method of marcotting now makes it possible to propagate selected high quality forms true to type. With a possible market for the juice and a successful method of propagation we are now in a position where selection of desirable fruiting forms of this plant becomes essential. It is hoped that anyone with a high quality strain of this fruit will report it to the variety committee of

this Krome Memorial Institute, or to the Subtropical Experiment Station, for examination as a possible horticultural variety.

The plant is slow to become established in the small size, but on becoming established, the growth is strong. The growth is spready with a tendency to produce long slender water sprouts from the base of the plant. For better fruiting it should be planted on well-drained soils that are inclined to be dry; on wet soils the vegetative growth becomes very rank to the detriment of fruiting.

The best fruit is borne on the slender mature twigs of the less vigorous branches. Careful pruning will be necessary to restrict the strong water sprouts and to keep the plant in workable control. The plant is a straggly shrub and may be pruned as an individual bush or trained on a trellis or low wire fence as a vine. In either case, a pruning practice will have to be worked out in the event of commercial plantings.

The flavor of this fruit is very agreeable. A larger form of the subacid type, with a minimum of latex, could become

valuable as a table fruit. In the meantime it may be considered only as a fruit for processing. It is difficult to handle the juice expressed direct from the ripe fruit because of the latex present in the fruit. The juice must be extracted by boiling in order to separate the latex.

The plant flowers heavily in spring and matures the main crop during the early summer. It continues fruiting spasmodically throughout the summer until late fall. It sometimes bears off-season fruits during a mild wet winter.

In "The Food Plants of the Philippines" Wester gives the following analysis, or percentages, for the fruits of the two types:

*Karanda* (large acid fruit)—Water 83.17; Ash 0.78; Crude fiber 1.81; Protein 0.66; Fat 4.63; Carbohydrates 0.51; Sugar 7.35 Acidity as citric 2.09; Calories per kilo of food 753.

*Perunkilla* (smaller subacid fruit)—Water 83.24 Ash 0.66; Crude fiber 0.62; Protein 0.39; Fat 2.57; Starch trace; Carbohydrates 0.94; Sugar 11.58; Calories per kilo of good 745. (1 kilo equals 2½ lbs.)

## PHYTOPHONA SEEDLING BLIGHT, A NEW DISEASE OF FLORIDA AVOCADOS

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A new disease of Florida avocado seedlings was discovered in October 1947, in a large commercial nursery near Princeton. Nearly all of approximately 4,000 seedlings were attacked to some extent. The disease affected mainly the leaves but it also caused stem lesions

which sometimes resulted in breaking of the stems. The plants were rendered unsuitable for grafting, and the scions of plants already grafted were attacked and frequently killed. The seedlings, grown from the seed of several varieties, showed no observable difference in reaction to the disease.

The most conspicuous symptoms were present on matured leaves as large, irregular reddish-brown necrotic areas



Fig. 1. Symptoms of *Phytophthora* seedling blight on avocado.

(Fig. 1) that appeared to enlarge most rapidly along the larger veins. Lesions on young leaves were darker in color and such leaves were frequently curled and twisted. The terminal bud of many seedlings was killed. Stem lesions, observed only on succulent stems, were elongate, sunken, and dark in color, occasionally cracked, and sometimes resulted in stem breaking and the death of the plant. Stem lesions appeared to result from the progress of the disease from the petioles into the stem. Diseased plants showed a marked tendency toward lateral branch production from axillary buds.

Conidia of a *Phytophthora* were found uniformly in the necrotic areas though not in abundance. Isolations from the margins of the diseased areas resulted in pure cultures of a *Phytophthora* identified by Dr. C. M. Tucker, University of Missouri, as *P. palmivora* Butler. Conidia of this fungus, obtained from cultures, were atomized on uninjured leaves of seedlings which were then covered with a belljar for 48 hours. Initial disease symptoms were present 48 hours after inoculation as water-soaked spots on the leaves. These were generally circular until a major vein was contacted; subsequent enlargement was most rapid along the veins. All stem lesions resulted from the growth of the fungus into the stem from the leaf. Symptoms, as seen in the nursery, were evident after 5 to 7 days. The fungus was readily recovered from these lesions. Control plants, treated similarly, remained healthy.

A survey of the available literature disclosed only one record of the avocado being a host of this fungus. Tucker (1) listed the avocado as a host of *P. palmivora* in the Philippines and cited Reinking (2) as the authority. An examination of Reinking's publication revealed, however, that he did not identify the species of *Phytophthora* involved, but merely stated that: "It resembles somewhat the fungus that produces coconut bud rot, black rot of cacao and the rots of various other plants." While Reinking did not specifically identify the pathogen, his description and illustration of avocado seedling blight in the Philippines make it appear to be identical with the disease herein described.

The outbreak of this disease occurred during a period of heavy rainfall and high humidity. The disease became unimportant with the advent of drier weather and the moving of the plants to the open from the slathouse. Raising the plants in the open and spacing them so as to promote rapid drying should help to minimize or perhaps avoid this disease. Fungicidal controls were not tested, but copper sprays might be expected to provide some measure of protection.

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# ORNAMENTAL SECTION



# CONTROL OF SEVERAL SCALE INSECTS BY MEANS OF A NEW INSECTICIDE

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*Introduction.* The nurseryman and home gardener can at last anticipate combating some of the scale insect pests with positive results. Recent preliminary investigations involving Parathion, a new organic insecticide, have given results which indicate that this is now within the realm of probability. Should some of the other organics fill in where Parathion is weak or where it fails this will be an actuality—at least for most of the now known important pests. The initial tests were made August 12, 1948 in an attempt to explore the field of new insecticides for a more effective material to be used in controlling scale insects on woody ornamentals. The insecticide was used against the following scale insects: Florida wax scale, *Ceroplastes floridensis* Comst., Florida red scale, *Chrysomphalus aonidum* (Linn.) and tessellated scale, *Eucalymnatus tessellatus* (Sign.). All of the tests were carried out in the University of Florida Horticultural Gardens. The tests on camellias and gardenias were conducted with the cooperation of Mr. R. J. Wilmot, Assistant Horticulturist, Florida Agricultural Experiment Station.

*Materials used.* The sprayers used were (1) a Champion All-Purpose double action knapsack sprayer, and (2) a Dobbins 1-quart continuous hand sprayer. The insecticide used was Parathion. The two formulations of the insecticide

used were (1) Experimental Insecticide 3422, 25 percent wettable powder, furnished by American Cyanamid Company, and (2) Vapophos 15 percent wettable powder furnished by California Spray-Chemical Corporation. The concentrations used will be given under the individual tests. Hereinafter, when 25 percent wettable powder is used, it is to be assumed that this refers to Experimental Insecticide 3422. Applications were made by the writer and it is felt that coverage was better than average.

*Effectiveness of Insecticides.* In the first test the insecticide was applied to 4 holly trees infested with Florida wax scale. One of these trees also had a heavy infestation of Florida red scale while a second had a light infestation of tessellated scale. Application of 25 percent wettable powder, at the rate of 1 pound per 100 gallons of water, was made on August 12, 1948. Examination of leaves brought into the laboratory 5 days after treatment indicated complete control of this insect. It was also noticed that numerous scales had dropped off of the leaves. Examination of the trees also having tessellated and Florida red scale infestations indicated complete control of the tessellated scale but only partial control of the Florida red scale.

On August 19 a second test was made on 2 holly trees having heavy Florida wax and moderately heavy tessellated scale infestations. Most of the leaves on both trees were covered with sooty mold. Application was made at the rate of 1 pound of 25 percent wettable powder per 100 gallons of water. Observations

one day later indicated that many Florida wax scale specimens were already dead. It was also noted that numerous Florida wax scales had loosened and fallen off of the leaves. Many still present on the leaves had raised the posterior portion of the body away from the leaf while the mouth parts remained in the leaf tissue. Two days after application of the spray only an occasional live Florida wax scale was observed and these were always old scales found on the stems and branches. Observations made on the tessellated scale indicated 10 percent dead scale prior to treatment and 94 percent dead scale 7 days after treatment. Complete control of adult females and crawlers resulted 18 days after application. This material does not appear to act as an ovicide, as eggs continued to hatch and crawlers were present several days after treatment.

A third series of tests was set up to determine the effectiveness of this spray against Florida red scale infesting camellias. Twelve plants were selected, 9 plants having heavy infestations of Florida red scale and 3 plants having heavy tea scale infestations. In this series 3 plants were treated with 25 percent wettable powder at the rate of 2 pounds per 100 gallons of water, 4 plants treated with 25 percent wettable powder at the rate of 1 pound per 100 gallons of water, and five plants treated with Vapophos 15 percent wettable powder at the rate of 1 pound per 100 gallons. Application of sprays was made on September 16, 1948. In the only test involving Vapophos worthy of mention the action was slow on tea scale and almost ineffective against Florida red scale. The live count of tea scale made prior to treatment was 48 percent. The

live count had been reduced to 42 percent 11 days after treatment and to 8 percent 34 days after treatment.

The results were also poor on the plants treated with 25 percent wettable powder used at the rate of 1 pound per 100 gallons of water. Before treatment the count of tea scale was 60 percent living and 48 percent living 28 days after application.

Observations made on the plants treated with 25 percent wettable powder at the rate of 2 pounds per 100 gallons of water indicated an appreciable reduction in the number of live scales. Counts of Florida red scale on one plant treated at this rate showed 56 percent living prior to treatment, 12.5 percent 3 weeks, and 8 percent 4 weeks after application. On another plant the count of Florida red scale was 44 percent living before treatment, .76 percent 18 days after treatment (1 alive out of 130 examined) and 13 percent 23 days after treatment. (The discrepancy in the number of living scales counted 18 and 23 days after treatment was probably due to poor sampling rather than an actual increase in live scale. Of the 15 live scales counted 14 were found underneath the larger old scales and, were completely protected by them.) At this concentration the spray was especially lethal to Florida red young female scales, immature male scales, and crawlers. It also acts as a good ovicide on this species. Dried-up eggs were frequently found beneath the female scale. In this same test the live adult female tea scale count was reduced from 30 percent prior to treatment to 6.9 percent 24 days after treatment.

The fourth series of tests was initiated on September 24, 1948. Application of the spray was made with a Dobbins 1-quart capacity continuous sprayer to

determine the effectiveness of this method of application. Application of 25 percent wettable powder at the rate of 1 pound per 100 gallons of water was made to 3 camellia plants having heavy Florida red and tea scale infestations. These plants were located in a lath house. Counts of tea scale were 71 percent living prior to treatment and 14 percent 17 days after treatment. The Florida red scale count was 90 percent living prior to and 48 percent 21 days after treatment. Apparently good coverage of the lower surfaces of the leaves is very difficult to achieve with this type of sprayer. Also treated on this date with the same material and using the same sprayer were 8 potted gardenia plants. These plants were infested with whitefly, mealybug, tessellated scale, and Florida wax scale. The leaves and stems were also covered with sooty mold. The last observation indicated a complete cleanup of the pests and the plants were putting out considerable new growth.

The last series of tests was set up to try to determine the effectiveness of Vapophos and 25 percent wettable powder against Florida red and tea scale on camellias grown in the lath shed. These materials were used at the rate of 1 pound per 100 gallons of water. Neither concentration showed satisfactory control of tea scale. The 15 percent material reduced the live scale from 68 to 24 percent while the 25 percent material reduced the live scale from 73 to 17 percent. Both of these concentrations gave high reductions in the number of living immature tea scales. In considering the effectiveness of these materials against the adult females of Florida red scale, the higher concentration is superior;

however, on 1 bush, having a 90 percent live scale infestation prior to treatment with Vapophos, complete kill was obtained in 2 weeks. The 25 percent material gave complete control of Florida red scale on 1 plant in 10 days.

*Insecticide Phytotoxicity.* No apparent plant injury resulted from the application of this insecticide in the formulations used to any of the plants. Mention should be made that very little new growth, which presumably would be most susceptible to insecticidal injury, was observed at the time of application.

*Discussion.* From the studies made thus far it appears safe to apply this material at any time during the day or season without burning of plants or loss of effectiveness. The material is easy to work with and no harmful effects to the operator were noticed; however, the manufacturers' precautions were followed carefully. This material, like all others, requires thorough coverage to be effective. Many more experiments must be performed before the real value and limitations of this material will be known.

*Conclusions.* Parathion 25 percent wettable powder used at the rate of 1 pound per 100 gallons of water will give complete kill of Florida wax and tessellated scales infesting hollies and gardenias with a single application. It also causes the Florida wax scales to loosen from the leaves so that they drop off.

This material used at the rate of 2 pounds per 100 gallons of water gives a high percent of kill of Florida red scale adult females and complete kill of young female and immature male scales and crawlers. It also acts as an effective ovicide against this species of scale.

## THE HIBISCUS IN FLORIDA

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Outstanding among all the shrubs from the South Sea Islands and epitomizing all their mystic charm and glorious brilliance of color and elegance of form is the hibiscus. It had been made the official flower of the territory of Hawaii and is fast becoming the dominant note of color in Florida gardens and the tropics around the world. Multitudinous in sizes, forms, and colors, it fascinates the professional gardener, the landscape architect, and the amateur alike, and yet it is so easy to grow that it is almost like a weed.

Individual flowers of the hibiscus resemble the hollyhock, so well known in Northern gardens, and like it, belongs to the Mallow family. Unlike the hollyhock however, the hibiscus blooms are borne singly and a few at a time all over the plant rather than in a spike. During the coldest days of winter, there may be short periods when there will be few hibiscus flowers, but on the whole it might be said to be in bloom the entire year round. The flowers come in both single and double forms and almost all gradations in between. The colors range from pure white through all shades of pink and yellow and red down to almost black. Recent hybrids include lavender and purple shades, but no true blue flower has been developed as yet. Originally of one main color, the flowers in recent hybrids show all gradations and combinations of three or four colors at a time. Many have special markings in the throat which give those varieties a

distinctive appearance. While mostly scentless, some of the newer varieties have a noticeable fragrance and it is not unlikely that the enthusiastic hibiscus hybridizers may soon present us with a race of hibiscus of varying fragrances to match their beautiful forms and color.

In the 1880s, which is about as far back as we have any records, there were only 8 or 10 varieties of hibiscus in Florida. These included such old, well-known sorts as the red and pink versicolor, peachblow, double pink, and double blood red. In 1895, Egbert N. Reasoner brought in a single-flowered orange-salmon variety from Jamaica. Around 1900 H. B. Plant, the East Coast developer, is reputed to have introduced the Lutea variety, a single yellow with dark red eye from Hawaii. These were first planted on the grounds of the old Royal Palm Hotel in Miami, and it is said that he refused \$25 per plant for the first few plants that were available.

This, then, was about all the hibiscus that were available in Florida until 1913, in which year E. N. Reasoner sent out an assortment of some 12 or 15 varieties named after the heroines of Greek Mythology. The single salmon introduced in 1895 was renamed "Euterpe" in this list, and is so named today. Other varieties sent out at this time included "Venus," "Psyche," "Urania," "Minerva," "Terpsichore," "Melpomene," and others. Several introduced at that time have since been discarded because of poor growth, shy blooming, or other undesirable characteristics. The origin of these varieties is not definitely known at this time, but it is believed they were

seedlings raised by Mr. Reasoner from seed imported from Hawaii about 1908 or 1909. As a boy, I remember two rows of seedling hibiscus growing in the field on the west side of our old property at Oneco and I believe these named varieties were selected as the best of this lot of seedlings.

In the period from 1925-1930, George Anderson of Fort Lauderdale became very much interested in hibiscus, and through friendly connections in Hawaii, introduced a number of the varieties then current in Hawaii. By crossing these he raised many seedlings, some of which are among our better present-day varieties, such as "Florida Sunset," "Old Gold," "Neutrality," "Eddie," "Double Yellow 161," and "Nan Patterson." While an earlier double yellow had been originated by J. J. McCann of Punta Gorda, Anderson's Double Yellow 161 was a better grower and bloomer and more easily propagated and so became the first really practical double yellow to be widely disseminated. George Anderson will long be remembered for this contribution to Florida hibiscus, and, as this variety has never been named, there has been a recent movement to name it for him posthumously.

The single white variety with the pink style in the center, which is sometimes known as "Anderson's Single White," was not originated by him but was one of those brought in by him from Hawaii; the correct name being "Mrs. Ruth Wilcox" (named for the wife of the first director of the Hawaiian Experiment Station). The old double white which flushes pink in cool weather was also one of his introductions from Hawaii. George Anderson should also be given credit as the originator of a new type of hibiscus in which the single flowers have

the addition of a few modified petaloids attached to the "style" in the center of the flower. His variety "Nan Patterson" is believed to be the first of this type.

A little later than Mr. Anderson, Mr. James Hendry of the Everglades Nursery at Ft. Myers, Florida, became interested in hibiscus and began raising many seedlings. One of his earliest was a two-toned reddish-orange and gold double-flowered variety which he named "Mrs. W. W. White," but which is better known in the trade as "Talisman," since it resembles the Talisman rose in coloring. Mr. Hendry has many fine double yellow-flowered varieties to his credit, such as "No. 10," "No. 40," "No. 111," and "Betty Hendry." His "No. 40" is perhaps the largest-flowered double yellow to date, and his "No. 111" is perhaps the most fragrant yet originated.

Perhaps Mr. Hendry's greatest contribution to hibiscus culture, however, is his introduction of purple and lavender tints by crosses using pollen from *Altheas* (*Hibiscus syriacus*). "Myrna Loy" (Double Lavender) and "Dolores" (Double Purple) are the results of this work. His "Mahogany" is also a second generation cross from this parentage. "Stella Lykes" is a contribution to the petaloid group, and his "Y-11" is one of the strongest growing and most freely blooming of the single-flowered orange-yellow type.

About this same time, when Anderson was sending out his seedlings and Hendry was just getting started, the U.S. Department of Agriculture did its best to aid hibiscus culture, sending out three different lots of hibiscus to its list of collaborators. Most of these were varieties which had been introduced from Hawaii, but some were seedlings raised at Chapman Field and at the Puerto Rican Ex-



periment Station. Mr. T. B. McClelland, who was at Chapman Field at the time, was particularly interested in hybrids between the common Chinese type (*Hib. rosa-sinensis*) and the so-called "Japanese" or "Fuchsia" type (*Hib. schizopetalus*). The many fine hybrids of this parentage available today are largely due to his interest. Among the better known varieties disseminated by the U.S. Department of Agriculture are the "Mrs. Earle Anthony," the best known of the single yellows, and "Flamingo Plume," a very free-flowering double variety with the coloring of flamingo plumage.

Following the work of Anderson and Hendry, quite a number of others became interested in hibiscus culture and started making crosses and raising seedlings. World War II delayed this progress somewhat and only in the last year or two are some of these latest varieties becoming available. It is impossible to list all of these experimenters, but among the most prominent were Mr. Charles James and his sister, Mrs. McGee of Miami, who have such fine varieties to their credit as the "Charles James, Jr.," "Van's Delight," "Debutante," "Betty Shalk," "George Neff," "Lynn McGee," and "Mary Kelly." Mrs. Entwistle, also of Miami, has come out with such excellent varieties as the "Daisy Entwistle," "Fleda Hughes," and "Emmaline Lee." Mr. Ruhl of South Miami, has brought out such excellent varieties as "Elizabeth Arden," "Teddy Ruhl," "Cavalier," and "Senorita." Many others in the Miami area and elsewhere are also producing seedlings and will doubtless bring out many more new varieties.

With this number of varieties already in existence, believed to number probably in excess of 500, and likely to be doubled in the next 2 or 3 years, it be-

comes immediately apparent that some sort of central agency or clearinghouse is very badly needed to try to clarify discrepancies in present nomenclature and to act as an agency with which originators can register the names and descriptions of their new varieties. There being no such agency in existence, your author has been attempting to fill this vacancy temporarily, but will gladly relinquish the work to any qualified authority such as the University of Florida or the University of Miami, should they wish to take it up. In this work he has been ably assisted not only by all the above-named hybridizers but also by many others throughout the State, in Texas and California who have had an opportunity to compare hibiscus varieties in some quantity. Mr. W. B. Parnell of Miami, has been especially helpful and his splendid collection of varieties has been most useful in obtaining descriptions, as has also Mrs. Zapain's collection at the Valencia Gardens and Mr. Penney's, also in Miami.

Names and descriptions are now on file for close to 400 varieties, and it is hoped that early this coming summer this work shall have become sufficiently stabilized to allow the production of a mimeographed list of varieties with descriptions. As considerable work is necessary in the production of a bulletin of this sort, a nominal fee of \$1 will be charged for these when ready. Much later, probably several years away, all this information should be published in book form with some colored illustrations, but this will depend on the interest shown in this work by the higher educational authorities, or the creation of some sort of Hibiscus Society.

In conclusion, it is well to remember that there are a great many very fine new

varieties of hibiscus now being originated in Florida, and with the interest shown and the number of experimenters now raising seedlings, it is not at all un-

likely that south Florida may soon be known as the leading center of hibiscus culture, rather than Hawaii, as at the present time.

## BROMELIADS IN FLORIDA HORTICULTURE

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Orlando

The cultivation of plants for ornamental horticulture is followed on the premise that beauty is a necessity in your life and mine. Horticulturally bromeliads have been developing, and in Florida they can provide a very pertinent addition to our gardens, creating more plant interest and decorative value than many other previous additions to the Florida scene.

Bromeliads in Florida are a natural. And in considering bromeliads for Florida horticulture first of all we must be aware that they are already here in the species of *Tillandsia usneoides*, (the ubiquitous Spanish Moss); in *Tillandsia utriculata* (the "Fountain Plant"), vicinity Vero and Merritt Island; in *Tillandsia tenuifolia* of southern Florida; in the *Tillandsia fasciculata* (Cardinal Plant), dense in the cypress swamps around Kissimmee; and in *Tillandsia recurvata* (Ball Moss), noticeable in trees along with the Spanish Moss and prominent on telephone wires all over Florida. Just why they seem so happy on telephone wires would afford a very interesting study.

There are ten other bromeliads less conspicuous in Florida. All but three of the seventeen bromeliads native to the United States are growing in Florida. While other States, Texas, Louisiana,

the Carolinas, and even the southern section of Virginia can claim some bromeliads, Florida can boast fifteen native species, twelve tillandsias, one guzmania and two catopsis. This affirms the fact that bromeliads like it here and therefore conditions are favorable to the introduction of others from afar.

If the bromeliads had not had to depend almost entirely on the wind for distribution we might have had still more species here in Florida. The ones we have, no doubt, came by way of Cuba and Mexico, as our native bromeliads are also found in these Caribbean countries. We might say that many centuries ago these air-fed, air-domiciled, air-borne seed plants established the first air communications between this country and our Latin American neighbors. Man who feels that he has advanced so considerably in the air needs only to study the ages old history of air-minded plants.

The bromeliads which have already traveled on their own as well as the ones which have traveled in the stomachs of beast and bird are now coming into Florida as introductions to horticulture by the man made air routes.

The native members of this great family (commonly known as the pineapple family) here in Florida are all epiphytes creating, thus, their own natural tree garden. You can see these

tree gardens when you travel from Orlando to Kissimmee or Holopaw; when you go to Melbourne or Vero; when you cross the Tamiami Trail or explore in the Royal Palm Park, or even in any native hammock. Thus the feature of an air garden already being established naturally, encourages the garden builder to go ahead and make a tree garden on the oaks or palms in his own yard using not only the natives but the horticulturally introduced exotics. Good gardening means, in one respect, doing what nature has already done especially in general planting utilizing native material wherever possible. So, in planning a tree garden for the home owner we always try to include some of our hardy native species, the Tillandsias or wild pines as they are sometimes called.

While man likes the little pat on his mental ego as being original we doubt very much if he ever is, rather he simply rediscovers and reapplies the features and principles which are inherent to everything throughout nature. So, while air gardens might be something new to many people, Floridians can point out to visitors our well established air gardens where not only bromeliads flourish but also epiphytic members of other families such as orchids, cacti, pipers, and ferns.

It is interesting to note that the native bromeliads in Florida occur on nine different species of conifers, those being five species of pines, two of cypress (*Taxodium*) on one white cedar and on one red cedar. Of course, the rough bark and great spreading branches of the live oak make this tree an ideal host for the air plants.

The tree gardens of Florida, however, are but a sample of tree gardens that exist in the Americas. In the Americas

south we have seen as many as 5,000 air plants living in one tree and although crowded, evidently quite happy. There seemed to be no evidence that the tree was burdened or imposed upon, rather it was adorned, apparently enjoying being host to harmless epiphytes rather than the harmful parasites.

In using bromeliads in Florida garden designs we have not limited our use of them to the air or tree garden. This versatile family has produced members which can be utilized in the rock garden, in the cactus garden, in the sheltered garden, on the seashore, and on the patio. These, of course, are the species which have been introduced from the other American countries; except for one species, the bromeliads do not grow outside of the South, Central, and North American countries.

There are already a number of exotic bromeliads in Florida horticulture; these came into Florida by way of Europe where years ago they were choice house and conservatory plants.

No doubt the early introductions of bromeliads into Florida came through the enthusiasm and appreciation of them by Dr. Henry Nehrling, Mr. Theodore Mead and Reasoner Brothers, all of whom had outstanding collections of bromeliads at one time which they received mostly from the European collections of bromeliads. You may have read the exuberant writings of Dr. Nehrling on this great family of plants. Florida, even now, 20 years since, remains host to the introduction of many new bromeliads; Florida now has one of the world's outstanding collections. From this collection bromeliads are being dispersed and sent to many other countries not only to bolster and renew the old collections but to distribute the new species that

have been discovered in the past few years.

There is one exotic bromeliad which came originally from Brazil which has already adapted itself to Florida gardens, and so much so that you might say it is common. It reproduces rapidly in our loose sandy soil; it also loves climbing up an oak tree; grows well in any area of thick leaf mold, or can do just as well in a pot. If you see no other bromeliad you will see this one. It is a *Billbergia pyramidalis*, having a plain green leaf-tube which sends forth a brilliant torch-like head of flowers late in the summer.

*Aechmea bracteata*, an introduced exotic, while not so common a bromeliad as the *Billbergia pyramidalis*, is nevertheless becoming distributed around Florida gardens. It is a native of the Caribbean area and so should be at home in Florida gardens. It stands our frosts of Central and South Florida very well. It produces heavy succulent leaves with big teeth, the plant sometimes becoming 5 or 6 feet high. In the spring a tall spike of brilliant red bracts and berries is produced which remains in full color for as long as 6 months. It is an epiphyte but adapts itself in porous soil very well.

The *Aechmea miniata discolor*, introduced many years ago, while not quite as well known as either the *Aechmea bracteata* or the *Billbergia pyramidalis* is nevertheless, around in many collections throughout the State. It is the first bromeliad that started my collection 20 years ago. Its beautiful satin-green leaves on the topside and the soft maroon underside make it a most pleasing plant. The long 3- to 4-month sustained bloom of brilliant red berries with blue petals give it an added charm that few plants have.

A third bromeliad which has already been in Florida horticulture a long time is the *Bromelia serra*, a large, sticky terrestrial which resembles the pineapple plant and even produces a cluster of fruits with a pineapple flavor. This bizarre looking plant is quite a sight in bloom. The center leaves turn brilliant flame-scarlet and out from them a great white cylindrical flower head, containing red bracts which cover maroon flowers, emerges gradually over a period of considerable time. No one can cease to thrill over this glorious display.

In our travels in South and Central America searching for new bromeliads for introduction into horticulture, we have found a bromeliad adaptable to almost every Florida condition.

For example: For our mangrove swamps there are beautiful *Porteas*, a genus of the bromeliads which produces showy flower stalks; these thrive in Brazil on the roots and trunks of the mangroves. Perhaps you have been confronted with the problems which a mangrove forest present. Let this problem be an opportunity for making an usual garden by establishing the large rosettes of the *Porteas* on the multiple-rooted mangroves. These *Porteas* are also quite adaptable to other parts of the garden.

We have found and introduced into Florida the gorgeous genus of *Quesnelia* whose species *Q. quesneliana* grows right down to the sand dunes of the beach front in Brazil. This large rosette of light green leaves produces a great watermelon-pink torch for a flower stalk creating a glorious sight down the beach.

One of the smaller types, *Aechmea nudicaulis*, can take the heat, drouth, and tough conditions of the littoral or the first line of growth back of the actual

beach. This bromeliad along with others will undoubtedly become a familiar plant personality among our introduced seaside planting as the years go along.

Numerous genera of this versatile family grow as epiphytes in the moisture-laden cloud or rain forests of Colombia, Mexico, Brazil, Ecuador, Dutch Guiana, Honduras, Costa Rica, to mention only a few countries whose bromeliads have found and can find favorable new habitation in the moist jungles, either natural or man-created of Florida. Two members in the genera *Catopsis* and *Guzmania* are already growing here in the State down on the lower tip of the Florida peninsula. They like excessive moisture and dark shade. Other members in these genera could make interesting additions to the wild or naturalized gardens of Florida.

A large number of terrestrial bromeliads are growing on or among rocks in their native haunts in Brazil, Peru, Chile, and elsewhere in the Americas. So, as introduced exotics, we have bromeliads in the genera of *Dyckia*, *Hechtia*, *Encholirium*, *Bromelia*, *Neoglaziovia*, *Orthophytum*, and *Ananas* which make excellent rock garden plants. These are gradually being introduced and propagated for the "new look" in rock gardens. A number of *Dyckias* have already been in cultivation and general distribution for a number of years, but there are many more, even more attractive, to be made known to the rock garden fancier. The other genera named are unfortunately very much less known but hold much interest for the courageous gardener who will risk something new. They not only have interesting and tough foliage but brilliant spikes of flowers of endless variety and color.

Two excellent rock garden bromeliads have proven to be in the genus *Neoregelia*, *N. spectabilis* (Painted Fingernail) and *N. marmorata* (Marble Plant) and hybrids of these. Their leaves become very red in full sun and their wire-like roots fasten themselves eagerly on the porous rocks of either coquina or limestone. The *Neoregelias* are more of an epiphytic type of bromeliad but they have adapted themselves so remarkably well in our own rock garden and others of central and south Florida that now we are recommending them as a colorful, novel addition to home-made rock gardens.

Not to be forgotten are the *Pitcairnia*s, a terrestrial leafy bromeliad which can be happy in the shaded garden either among rocks or near a pool. A number of the species remind one of tufts of grass such as *Pitcairnia flammea* until they produce their brilliant red tubular flowers on a branched spike which in some species continues to bloom for 2 months, such as *P. corallina*.

Why don't we have all of these recommended bromeliads now in Florida gardens? Well—some of them are like century plants to dig and to pack when collecting them in South America, so only a few are taken. Those few are badly damaged in transit and quarantine upon entering this country, it takes a year or so for them to make the adjustment to our side of the equator, and propagation is not fast. In other words, plant introduction is a slow process.

Bromeliads used as patio or house plants in Florida have few rivals in decorative plant form because of their brilliantly colorful flower spikes, their splendid leaves, and because of the minimum care required.

On the patio for either sun or shade

there are several choice bromeliads awaiting placement. With a reasonable amount of rain or watering they ask for no other care. These bromeliads can be selected from the genera *Aechmea*, *Quesnelia*, *Billbergia*, *Neoregelia*, *Dyckia*, *Hohenbergia*.

In the home the *Aechmeas*, *Nidulariums*, *Neoregelias*, *Billbergias*, and *Cryptanthus* make unusually successful indoor plants because of their characteristic adaptability and from a decorative standpoint, because of their highly colored foliage with their brilliant and long-lasting flower stems. Bromeliads lend themselves admirably to certain color schemes of the home, also to formal and informal furnishings. And for the busy housewife their need for only a minimum amount of care is always a desirable quality.

Looking on the economic side we find that there are just two outstanding species of bromeliads which are used commercially in Florida, the pineapple from Brazil and the Spanish Moss so prolific over this State as well as in other States and other countries. This "moss" has been successfully gathered, dried, and cleaned with a resultant fiber that makes excellent upholstery fiber now used extensively in airplanes, furniture, and automobiles. This manufacturing is being carried on near Jacksonville and Ocala, as well as in a number out-of-State locations.

Another large scale use of the Spanish Moss which we all are acquainted with, is its use as shade over plant beds. Instead of an expensive lath house Spanish Moss draped on chicken wire serves as a relatively inexpensive shade house.

Pineapples, the best known bromeliad, at one time were grown commercially on a much grander scale in Florida than

now, and what the future holds for Florida pineapples depends on research into better growing requirements peculiar to Florida.

There are other members of this family which have commercial potentialities but whether or not they will be developed here in the State remains to be seen. Undoubtedly the Florida climate is favorable, but the soil conditions are so dissimilar to the indigenous spots where the commercially potential bromeliads grow natively that there must be considerable research done to bring these plants into successful production.

Excluding the pineapple productions of Cuba and Hawaii, Brazil has possibly gone further in a commercial development of this family than any other country with their *Neoglaziovia variegata*, a tough whip-like bromeliad which produces an excellent fiber, finer and more durable than linen. This has become a very productive industry in north Brazil in the states of Bahia Pernambuco, and Paraiba.

The bromeliads yield another excellent fiber plant in *Aechmea magdalena* which is utilized extensively by the Indians in Mexico and Colombia for twine and rope. So far as we know it has not been industrialized but holds considerable potentiality, and, undoubtedly could be more favorably adjusted to our Florida soil than the *Neoglaziovia*.

Generally speaking, the versatile bromeliads have already given Florida a most interesting native flora; they have added by their introduced species an unusually different decorative value for the home garden, and hold within the 52 genera varied commercial potentialities whenever they can be adapted to Florida conditions.

# WITCHES BROOM OF OLEANDER

ERDMAN WEST

MYCOLOGIST

*Florida Agricultural Experiment Station*

The common oleander *Nerium oleander* L.) is a widely grown ornamental in private and civic plantings in Florida. It has gained this popularity because it makes vigorous growth under a variety of soil and moisture conditions, has a pleasing range of color in the flowers and is affected by few serious troubles. The most serious fungous disease of oleander in Florida is called "witches broom."

## SYMPTOMS OF WITCHES BROOM

The outstanding characteristic of witches broom disease is the abnormal branching of the oleander stems. Healthy young stems rise from the crown, straight or slightly curved and without branches except near the top. Older stems or trunks may bear several upright branches, usually scattered along the main stem. Shrubs affected by the witches broom disease bear one to many rosettes or dense clumps of small slender branches 10 to 18 inches in length. They always occur at a node or joint on the stem. These dense clusters of small branches vaguely resemble a broom, hence the common name "witches broom" disease. The brooms are usually attached to one side of the stem although they may extend all the way around it. Without exception they occur on wood 6 months or more old. On small stems there may be only 2 or 3 of the slender twigs in the broom but in most cases they number over 20. Rarely a broom may consist of more than 50 shoots.

The individual stems on the broom are unbranched and curve upward from a common base so that the cluster appears quite dense. The twigs in a broom never bear flowers. The brooms may occur anywhere along a stem from near the top of the bush to the base near the ground line. Some swelling of the stem is evident at the point of attachment. In cases of long standing almost every stem will show this multiple branching near the base and the lower part of the clump will be a mass of weak slender stems. The top of such a bush will never appear vigorous and healthy and no flowers will ever be produced.

If the brooms are left undisturbed they will die in a few months after formation. First the slender twigs lose their leaves then shrivel and become dark brown or black in color.

## DISTRIBUTION OF WITCHES BROOM

Witches broom of oleander has been reported only from Florida. In this State it has been found as far north as Ormond on the East Coast and Clearwater on the West Coast. In the South its range extends as far as oleanders are grown. The disease appears to be much more common and severe within a few miles of the coast but it occurs occasionally in some of the inland counties. Specimens have been seen from Palatka, Leesburg, and two localities in the ridge section, Lake Placid and Sebring.

A kind of witches broom of oleander, caused by a virus, is being investigated in California but there is no published information on it at present. It seems quite distinct from the Florida disease.

#### CAUSE OF THE DISEASE

The cause of witches broom on oleander in Florida is a fungus (*Sphaeropsis* sp.). It obtains entrance at a node and grows into the tissues stimulating the formation of an abnormal number of vegetative buds (multiple buds) many of which develop into slender twigs. All the tissues remain green and succulent while this formation is developing and there is no outward indication that any organism is involved. As soon as the twigs begin to die and turn brown numerous small pustules begin to develop, especially near the bases of the twigs. By the time the twigs are completely dead, these pustules are mature, black, and exuding thread-like masses of black microscopic spores. These spores are distributed to other parts of the plant or to other plants by rain, wind, and perhaps on the feet of birds or the hands of man if healthy plants are touched after handling the dead brooms. Rain washes the spores down the stems to their bases where the brooms in the crown of the plant are initiated.

Although there is no outward indication of a fungus on the green twigs of the witches broom, the causal organism can be isolated readily in the laboratory by planting tiny bits of the diseased tissue on sterile culture media. Fragments of the fungous growth from the culture media promptly produce the disease when inoculated in slight wounds on healthy stems. Brooms are produced if the inoculation is made very near or at the node. Inoculations between the nodes causes a slight swelling of the stem and later a dead area of bark on which is produced a great number of pycnidia, as the spore-bearing structures of the fungus are called. Ap-

parently the fungus is not able to spread very far up or down through the oleander stem tissue because these inoculations never produce brooms on the nodes above or below the point of inoculation. One such inoculation was observed in the greenhouse for three seasons without brooms developing on the stem bearing the canker. These dead spots or cankers in the bark nevertheless produce many spores capable of spreading the infection.

#### CONTROL MEASURES

Witches broom of oleander is not easily controlled, especially in old plantings where the disease is long standing. Individual brooms can be eliminated by pruning, cutting off the broom a joint below the point of infection. If this is done while the twigs are green, spread of the disease from this particular broom is eliminated because no spores are shed until after the broom dies. All prunings of this sort should be burned because the fungus can continue to grow and mature spores even after the broom is removed from the plant, especially during rainy weather. Close watch should be kept over affected bushes and all brooms removed as soon as they can be recognized. If many brooms are removed and especially if any of them are dead and shedding spores, a good copper-containing fungicidal spray should follow to kill any spores lying on the surface of the plant. This procedure is satisfactory only if there are no other infected bushes near by from which new infections may arise.

In cases where the infection has spread to the bases of the stems of a clump it is impossible to remove all the infected material by pruning. Such plants should be dug up and destroyed.



Spraying alone will not eradicate the disease. Setting young healthy plants in the same area is a fruitless endeavor until all infections in the vicinity have been removed. In other words, the control of oleander witches broom disease is a community project in which all owners of diseased plants must cooperate.

## EXHIBIT "A"

## FLORIDA STATE HORTICULTURAL SOCIETY

Leo H. Wilson, Treasurer

Sarasota

## Balance Sheet

October 25, 1948

## ASSETS

## GENERAL FUND ASSETS:

Petty Cash Fund	\$ 7.00
Checking Account—Palmer National Bank & Trust Company	551.00

Total General Fund Assets	\$ 558.00
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## ENDOWMENT FUND ASSETS:

Savings Account—Palmer National Bank & Trust Company	\$ 253.02
United States Savings Bonds, Series F	

(per Schedule 1):

Maturity Value	\$11,025.00
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Cost	\$8,158.50
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Accrued Interest to 10/25/48	209.70
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Redemption Value, 10/25/48	8,368.20
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Total Endowment Fund Assets	8,621.22
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TOTAL ASSETS	\$9,179.22
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## LIABILITIES AND SURPLUS

Liabilities	\$ -0-
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## GENERAL FUND SURPLUS:

Balance, as at 10/22/47	\$1,630.22
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Less Excess of Disbursements over Receipts for Period 10/22/47 to 10/25/48 (per	
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(Exhibit B)	1,072.22
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Balance, 10/25/48	558.00
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## ENDOWMENT FUND SURPLUS:

Balance, as at 10/22/47	\$8,429.74
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Plus Increases for Period 10/22/47 to 10/22/48:	
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Cash Receipts (per Exhibit B)	\$100.88
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Increase in Redemption Value of	
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U. S. Savings Bonds during Period	90.60	191.48
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Balance, 10/25/48	8,621.22
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TOTAL LIABILITIES AND SURPLUS	\$9,179.22
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## RESOLUTIONS

Whereas, the orderly production and marketing of Florida Citrus, vegetables, cattle, field crops, honey, and flowers requires that producers and shippers have currently available to them more accurate information as to probable production and crop conditions; and

Whereas, the Florida State Horticultural Society recognizes the necessity for placing in the hands of producers and shippers current facts as to crop production and condition that will enable them to deal more advantageously with those who purchase these agricultural products; and

Whereas, the funds and personnel of the Federal State Crop Reporting Service are insufficient to permit this type of information to be assembled, compiled and distributed in time to aid the producer and shipper in making intelligent decisions that will help to avert periodic over and under supplying of the Nation's markets, to the detriment of the producer;

Therefore be it resolved by the Florida State Horticultural Society that:

1. The legislature of the State of Florida be urged and requested to appropriate from its general revenue fund the sum of \$50,000 annually, supplementing the funds already provided by the Federal and State governments, in order that the Crop Reporting Service may be enabled to assemble and compile the current information so essential to orderly production and marketing; and

2. That the Florida Agricultural Council be asked to join with this Society in sponsoring the enactment of the desired legislation.

Whereas, budwood from apparently healthy trees can carry the dread Tristiza and Quick Decline disease, and

Whereas, there are probably other virus diseases that can be carried in the same manner, which would entail calamitous loss to the citrus industry of Florida,

Therefore be it resolved, that each member of the Florida State Horticultural Society should cooperate with the State Plant Board and the Bureau of Entomology and Plant Quarantine, in seeing that living plants or parts thereof are not illegally brought into this State from points without.

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Whereas, the operations of various parts of the University of Florida are of greatest importance to all horticulturists in this State, and

Whereas, the enrollment has increased 250 percent but facilities have not been increased to cover this, and

Whereas, a plan has been developed by the University heads for increasing the facilities for teaching and research, which, if carried out, will be adequate.

Be it resolved, that the Florida State Horticultural Society does endorse this plan for the expansion of the University of Florida, and

Be it further resolved, that we request the State legislature and budget commission to make sufficient funds available for this purpose and we further authorize the officers of this Society to make every effort to see that this program is carried out, and

Be it further resolved, that a copy of

this resolution be sent to J. Hillis Miller, President of the University of Florida.

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Whereas, citrus growers and processors will be benefited by standards which will reasonably assure purchasers of a satisfactory product, and

Whereas, this can be accomplished by modern methods without undue hardship on any canner or processor,

Now therefore be it resolved, that the Florida State Horticultural Society does endorse the standards proposed by Processed Foods Division of P. and M. A., as modified by Citrus Products Research Council, and as endorsed by the Florida Canners Association.

Copies of this resolution to be sent to United States Secretary of Agriculture, Citrus Products Research Council, and to the Florida Canners Association.

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Whereas, fresh frozen citrus concentrate has met ready consumer acceptance, and

Whereas, there is a possibility that some processors might cut back the old eight-to-one heated concentrate with fresh orange juice, freeze this mixture and offer it to the trade in competition with the new and highly acceptable fresh frozen concentrate,

And whereas, we believe the fresh frozen concentrate should be protected by adequate label requirements.

Therefore, be it resolved, That the Florida State Horticultural Society does respectfully call this to the attention of P and MA and the Food and Drug Administration and urge that proper "true label" requirements be promulgated.

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Whereas, lack of organized and controlled marketing is the primary cause

of the present disastrously low citrus prices, be it

Resolved, that the Florida State Horticultural Society assembled in West Palm Beach, Florida, for its sixty-first annual meeting, joins the Citrus Committee of the Florida Bankers Association and many other organizations of business men in urging all citrus growers to join Florida Citrus Mutual immediately.

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Whereas, the Japanese beetle is established in North Carolina and elsewhere in the North and may be brought into Florida on plants or in soil. Therefore be it

Resolved, that the Florida State Horticultural Society assembled in West Palm Beach for its sixty-first annual meeting, calls this fact to the attention of all Florida citizens and urges them to bring no plants or soil into Florida from North Carolina or elsewhere.

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The Florida State Horticultural Society members and officers attending the sixty-first meeting in West Palm Beach, wish to thank the following: Reverend E. F. Carwithen, Honorable George McCampbell, Mr. and Mrs. Ed Stumpf, and the West Palm Beach Chamber of Commerce for their assistance in publicity and registration, The George Washington Hotel, Mr. Leach, manager and his associates, and The Local Committee under the direction of Mr. R. A. Carlton, for their assistance throughout the meeting.

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#### Auditing

We, the members of the Auditing Committee, beg to report that we have examined the books, vouchers, state-

ments, and reports of the treasurer of the society and find them to be correct.

Respectfully submitted,

J. R. Wilmot

O. C. Minton

W. L. Tait, Chairman.

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### **Necrology**

Frank W. Ross, 48, a resident of Oakland, Florida, for 25 years, died from an automobile wreck March 17, 1948. He

was born in Marion County, Florida, December 29, 1899. Parents were H. A. and Annie Laurie Ross. Since coming to Orange County he had been engaged in the citrus industry. He was a member of the Presbyterian church and twice president of West Orange Athletic Association. He is survived by his widow, Catherine Ross; one son, Jack Hugh; his father; one brother, H. A. Ross, Jr., and one sister, Betty.

## **FLORIDA STATE HORTICULTURAL SOCIETY OFFICERS ELECT FOR 1949**

### **MINUTES EXECUTIVE MEETING**

**West Palm Beach**

**October 26, 1948**

The following were present: Jamison, Schneck, Beckenbach, Wilmot, Stirling, Edsall, Ward, Miller and Wilson.

A motion was made by Jamison, seconded by Schneck, to include the Ornamental and Processing groups as sections of the Society, and passed unanimously.

A motion made by Jamison, seconded by Edsall, to have a general president of the Society and a vice-president for each section including Citrus, Krome, Vegetable, Ornamental and Processing, passed unanimously. The vice-president of each section is to arrange for and have charge of the program for each section.

A motion by Beckenbach, seconded by Jamison, to combine the secretary and treasurer positions into one office, passed. This motion stated that this

position should be allowed up to \$300.00 per year for services for the Secretary-Treasurer.

A motion by Wilmot, seconded by Edsall, to have the Society definitely listed as a non-profit organization if it is not already so listed.

Meeting adjourned.

### **GENERAL BUSINESS MEETING OF SOCIETY**

**West Palm Beach**

**October 28, 1948**

The Secretary reported the action of the Executive Committee and made a motion that the Society approve the Executive Committee action. This was seconded by Edsall and passed.

The report of the nominating committee was read and officers for 1949 unanimously elected as listed in the front of this Proceedings.

The meeting was adjourned.





**I. A. R. I. 75.**

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